Seafood

Shrimp fishing.
(Credit: Maxwell Hohn)

Summary

Unsustainable resource extraction is one of the great threats to our oceans, and this includes unsustainable harvesting of seafood by both recreational and commercial fishers. Recently, an increasing number of sports anglers have been attracted to the Sound by recovering fish stock, such as Chinook salmon. However, other species such as pink salmon have variable population estimates, and therefore their sustainability is uncertain. Monitoring population size is important to maintain healthy fish stocks; however, critical funding for monitoring salmon return in the Cheakamus River – the only consistent indicator of salmon population dynamics in the watershed – has been cut.

By contrast, the shrimp and prawn fisheries in Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound benefit from strong monitoring programs, which result in fishery closures when stocks drop too low. Due to the indiscriminate nature of fishing methods, the shrimp trawl fishery has been closed throughout Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound since 2017 due to low stock numbers. Further actions to protect sensitive habitat and species, such as glass sponge reefs, include using improved fishing technology and gear, closing certain areas to bottom trawling and promoting fishing methods to decrease bycatch.

Both sport fishing and the shrimp/prawn fisheries are likely to be negatively impacted by climate change because many of these species prefer cooler water temperatures. Warmer waters, droughts and floods will impact the survival of all life stages of these species. Taking action to address climate change, implementing long-term fish monitoring programs where they are lacking, and protecting fragile habitats will be key moving forward.

Ocean Watch Health Rating

HEALTHY 1) The status is healthy according to available data, 2) the trend is positive if known, 3) some data are available, and/or 4) actions to address or mitigate are well underway and are known to be effective. Actions should be taken to maintain positive status and/or trend.

CAUTION Status, trend, data, and/or actions provide contradictory or inconclusive information. Actions are needed to move into positive status and trend and avoid negative status and trend.

CRITICAL 1) Impacts or issues are high risk or have resulted in a low or vulnerable status, 2) improvements are uncertain, minor, or slow, and/or 3) actions to address or mitigate are non-existent, vague, or have low effectiveness. Actions are needed to move into positive status and trend.

LIMITED DATA/ NOT RATED Not rated due to the nature of the article, or there are not enough data to produce an assessment.

ARTICLE + 2020 RATIONALE	2017	2020
SPORT FISHING Pressure on fish stocks continues to increase from the rising popularity of sport fishing. There is a lack of monitoring to support stock management and enforcement of regulations.	!	! ↓
SHRIMP/PRAWN FISHERY Stocks have been declining since 2015, resulting in fishery closures. Industry is trying to decrease bycatch mortality.	!	!

Sport Fishing: more anglers increase pressure on fish stocks

AUTHORS

Stephanie Lingard, Project Biologist, Instream Fisheries Research

Aroha Miller, Manager, Ocean Watch, Ocean Wise Research Institute

REVIEWER

Dave Brown, Vice-Chair of the Squamish Lillooet Sportfish Advisory Committee

What is happening?

Visitor numbers to Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound have continued to grow since 2017. Consequently, more anglers have increased pressure on local sport fishing areas and fish species. Anglers and conservationists have repeatedly asked for additional enforcement efforts in the Squamish River and Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound; however, both federal and provincial agencies have been slow to respond.

Sport fishing in Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound. (Credit: Dave Brown)

What is the current status?

Sport fishing in Átl'ka7tsem/Txwnéwu7ts/Howe Sound is benefiting from increases in some salmon stock. However, it is also experiencing challenges, such as threats to fish survival under certain river conditions and a reduction of data collection to support effective management.

An increase in Chinook salmon has been observed throughout Átl'ka7tsem/Txwnéwu7ts/Howe Sound by hatcheries and anglers. At the Tenderfoot Creek Hatchery, returning Chinook adults were seen in all river systems during summer 2018. This was the first time a return had been observed in the hatchery's four years of operation. Then, in summer 2019, large numbers of four and five-year-old hatchery adult Chinook were caught and reported at Tenderfoot Creek.[1] Anglers have benefited from this increase in Chinook in the Sound.[2]

Pink salmon (*Oncorhynchus gorbuscha*) return to spawn every two years. In odd years between 2011 and 2017, large returns of pink salmon adults to the Squamish River watershed drew anglers to the area. Because of the large returns, a commercial fishery was opened in Átl'ka7tsem/Txwnéwu7ts/Howe Sound for pink salmon in 2013. However, because there was no stock assessment of this species in Átl'ka7tsem/Txwnéwu7ts/Howe Sound to use for setting quotas, the commercial fishery was shut down in August 2015[3] and has not been re-opened. Nonetheless, data from the Cheakamus River indicates a declining trend in estimated juvenile pink salmon abundance since 2015, although there is clearly high variability in numbers.[4] Anglers, however, continue to enjoy sport fishing for pink salmon, one of the only sport fish species allowed to be retained.

Ramping[i] events are a concern for fish populations using rivers with hydroelectric facilities. In 2018, a fish

Happy young angler. (Credit: Dave Brown)

i) Ramping – increasing or decreasing the water flow on a run-of-river hydroelectric project, which can result in fish being stranded and dying if the water levels drop too quickly.

fry[ii] stranding occurred in the Cheakamus River due to a ramping event that aimed to control the release of water from BC Hydro's hydroelectric facility at Daisy Lake Dam.[5] In September 2019, another large ramping event on the Cheakamus River resulted in considerable numbers of dead pink salmon, many of which had not yet spawned. Additionally, this event destroyed salmon redds[iii].[6] The number of fish being stranded and dying after ramping events and the frequency of these events is highly concerning for the local community.[2]

Unfortunately, the long-term monitoring programs in the Cheakamus River that were a part of a Water Use Plan for BC Hydro, ended in 2019. The monitoring provided the only consistent indicator of salmon population dynamics in the Squamish River watershed. The loss of this program will result in government agencies no longer having long-term monitoring data to guide resource management decisions such as fisheries quotas and closures.

What are the potential impacts of climate change on sport fishing?

Climate change is likely to have significant effects on the sport fishery in Átl'ka7tsem/Txwnéwu7ts/Howe Sound. Increasing water temperature, summer droughts and high discharge volumes due to extreme precipitation events are forecasted to increase under current climate change projections.[7,8] All these conditions have negative impacts to anadromous[iv] salmon and trout that make up a large component of the sport fish in Átl'ka7tsem/Txwnéwu7ts/Howe Sound. However, positive impacts from climate change are also being observed for particular species. In recent years, elevated ocean temperatures have been linked to the higher abundance of Northern anchovy (*Engraulis mordax)* in the Salish Sea.[9] This positive correlation is likely to exist only up to a certain temperature threshold. Anchovy are an important forage fish in the Átl'ka7tsem/Txwnéwu7ts/Howe Sound food web.

Warmer water temperatures and droughts are likely to negatively impact the survival of all life stages of salmon from egg to adult. Energy use in fish is higher in warmer temperatures, and fish in warm water become stressed, which can lead to an increase in disease.[10] Storm events can wash fish out of rivers before they are ready to migrate or damage the eggs laid in redds. High river discharges also affect the ability of migrating adult salmon to enter spawning habitats, reducing the success of spawning events.[10,11]

ii) Fish fry – small young fish that are just emerging from their gravel nest.

iii) Redd – a depression in the riverbed where female salmon deposit eggs during spawning.

iv) Anadromous – moving into rivers from the sea to spawn.

What has been done since 2017?

The table below reports on progress made on recommended actions from the previous 2017 article, where identified. Many of these require ongoing action.

2017 ACTION	ACTION TAKEN
INDIVIDUAL AND ORGANIZATION ACTIONS	
Ensure you are familiar with the current regulations before you fish.	Three educational signs were installed in the Squamish River watershed in summer 2017. Signs display species information including identification, where to look for fishing regulations and locations of Sḵwx̱wú7mesh Úxwumixw/Squamish Nation lands. These signs were placed at high traffic areas of the Squamish River (i.e., the Squamish Spit, Fisherman's Park and at the confluence[v] of the Mamquam and Squamish rivers).
GOVERNMENT ACTIONS AND POLICY	
Support grassroots stewardship programs.	Some groups are supported by government funding. For example, the Tenderfoot Creek Hatchery (run by Fisheries and Oceans Canada [DFO]) provides fish to the Bowen Island Terminal Creek Hatchery, run by the Bowen Island Fish and Wildlife Club (BIFWC), a citizen science group.
Undertake baseline data studies to better determine fish populations, behaviours and returns so that conservation projects can be implemented, and retention, commercial harvests and industrial projects allowed only when supported by sufficient data.	The long-term monitoring programs in the Cheakamus River that were a part of a Water Use Plan for BC Hydro, ended in 2019. The monitoring provided the only consistent indicator of salmon population dynamics in the Squamish River watershed. This is a contrary move to the recommended action.

v) Confluence – the joining of two rivers.

What can you do?

A detailed overview of recommended actions relating to climate change is included in *The path to zero carbon municipalities* (OWHS 2020). In some cases, no progress was identified on previous recommended actions; these remain listed below. Additional actions marked as NEW also follow.

Individual and Organization Actions:

- Take fishing lessons to learn proper fish handling techniques.
- Take your garbage and used fishing line with you when you leave your fishing spot.
- Avoid unwanted and illegal rockfish by fishing away from rocky reef areas, key habitat for these fish.
- Sport fishing organisations and guides/outfitters can collect data on participants and catch and share the data to aid in quantifying the value of the activity to Átl'ka7tsem/Txwnéwu7ts/Howe Sound.
- Participate in shoreline cleanups.

Government Actions and Policy:

- Require angler education through the licensing process.
- Make angler awareness programs available in multiple languages.
- Allocate more resources toward monitoring and enforcement of recreational fishing regulations. Ensure saltwater "guides" are licensed.
- Increase levels of protection for forage fish species such as herring, eulachon and anchovy as they are main food sources for Pacific salmon and some marine mammals in Átl'ka7tsem/Txwnéwu7ts/Howe Sound.
- Require saltwater guides to be licensed and test their knowledge regularly.
- Unlink the allocation of DFO Conservation Officer enforcement funds with volume of reported infractions and increase enforcement capacity especially in heavily fished areas.
- NEW Implementation of ongoing long-term fish monitoring projects in this area.
- NEW Support surveys of angler activity and catch statistics.
- NEW Establish citizen enforcement officers throughout the Sound, who are granted limited enforcement powers, such as checking catch size, species, and fishing method, and handing out fines for fisheries infringements.

Methods

Literature was scanned for potential impacts of climate change on sport fish species.

Resources

This list is not intended to be exhaustive. Omission of a resource does not preclude it from having value.

Reeltime M, 2017. Massive school of anchovies in Howe Sound, May 2017 https://youtu.be/xgNKco-h1-s. Accessed October 17, 2019

Taylor, A 2017. Howe Sound Anchovy, October 2017 https://youtu.be/qQ9-yv1F28g. Accessed October 17, 2019

Educational signage placed along the Squamish River. (Credit: Stephanie Lingard)

References

1 Fisheries and Oceans Canada (DFO). Tenderfoot Creek hatchery report – September 2019. 2019.

2 D. Brown, personal communications, 2019 Nov 4. Anecdotal report that Chinook salmon numbers increased in Howe Sound.

3 Barrett B. Controversial commercial fishery on Howe Sound shut down. Pique News Magazine [Internet]. 2015; Available from: https://www.piquenewsmagazine.com/whistler/controversial-commercial-fishery-on-howe-sound-shut-down/Content?oid=2669515

4 Lingard SA, Putt N, Burnett C, Melville C. Cheakamus River juvenile salmon outmigration enumeration final data report. Squamish; 2018.

5 Barrett B. BC Hydro reviewing ramping rates after fish fry stranded on Cheakamus River. The Squamish Chief [Internet]. 2018; Available from: https://www.squamishchief.com/news/local-news/bc-hydro-reviewing-ramping-rates-after-fish-fry-stranded-on-cheakamus-river-1.23412840

6 Thuncher J. Mass fish kill on river in Squamish. The Squamish Chief [Internet]. 2019; Available from: https://www.squamishchief.com/news/local-news/mass-fish-kill-on-river-in-squamish-1.23964549?fbclid=IwAR28Q6zEqyRJRoTQV1ETGQfEMSwzI4ucW-BZfsitd8MX6f4rs4By9sCmq1A

7 Van Vliet M, Franssen W, Yearsley J, Ludwig F, Haddeland I, Lettenmaier D, et al. Global river discharge and water temperature under climate change. 2013;23:450 – 464.

8 Tohver I, Hamlet A, Lee S-Y. Impacts of 21st-Century Climate Change on Hydrologic Extremes in the Pacific Northwest Region of North America. J Am Water Resour Assoc. 2014;50:1461 – 1476.

9 Duguid WDP, Boldt JL, Chalifour L, Greene CM, Galbraith M, Hay D, et al. Historical fluctuations and recent observations of Northern Anchovy Engraulis mordax in the Salish Sea. Deep Res Part II Top Stud Oceanogr [Internet]. 2019;159:22–41. Available from: https://doi.org/10.1016/j.dsr2.2018.05.018

10 Rand P, Hinch S, Morrison J, Foreman M, MacNutt M, Macdonald J, et al. Effects of river discharge, temperature, and future climates on energetics and mortality of adult migrating Fraser River sockeye salmon. Trans Am Fish Soc. 2006;135:655–67.

11 Minke-Martin V, Hinch S, Braun D, Burnett N, Casselman M, Eliason E, et al. Physiological condition and migratory experience affect fitness-related outcomes in adult female sockeye salmon. Ecol Freshw Fish. 2018;27:296–309.

Shrimp and Prawn Fisheries: managing declining stocks

AUTHOR

Amber Dearden, Research Assistant, Ocean Watch, Ocean Wise Research Institute

REVIEWER

Dennis Rutherford, Science Advisor, Pacific Prawn Fishermen's Association

What is happening?

Within Átl'ka7tsem/Txwnéwu7ts/Howe Sound, commercial and recreational fisheries have traditionally targeted spot prawn (*Pandalus platyceros*) via trap, and pink (smooth [*Pandalus jordani*] and spiny [*Pandalus borealis*]) and sidestripe shrimp (*Pandalopsis dispar*) via bottom trawl methods. Wild spot prawns in coastal B.C. harvested via trap are considered sustainable as per the Ocean Wise Seafood Program.[1] However, the sustainability of pink and sidestripe shrimp harvested by trawl is still under review due to potential interactions between fishing activity and sensitive marine species and habitats, such as glass sponge reefs and corals.

Pacific Prawn Fishermen's Association survey photos, October 2019. (Credit: Maxwell Hohn)

What is the current status?

Although annual stock sizes can vary, regional declines in pink and sidestripe shrimp stocks have been observed since 2014. Declining stock size has led to the closure of the Fraser River Shrimp Management Area (SMA), which includes Átl'ka7tsem/Txwnéwu7ts/Howe Sound waters.[2–4] Prawn stock status (based on using commercial catch as a proxy of abundance) in Átl'ka7tsem/Txwnéwu7ts/Howe Sound has been more variable, with a record low catch in 2017, followed by a slight increase in 2018 (Figure 1).

Stock status of pink and sidestripe shrimp is estimated using data collected during annual fishery independent trawl surveys conducted by the Fisheries and Oceans Canada (DFO). In 2017/18, stock size of pink shrimp in the Fraser River SMA was estimated to be below the Limit Reference Point (LRP)[i] and in the critical zone[i].

i) Limit Reference Point (LRP) = ~30% of estimated sustainable yield; Critical zone – stock status falls below the Limit Reference Point (LRP).

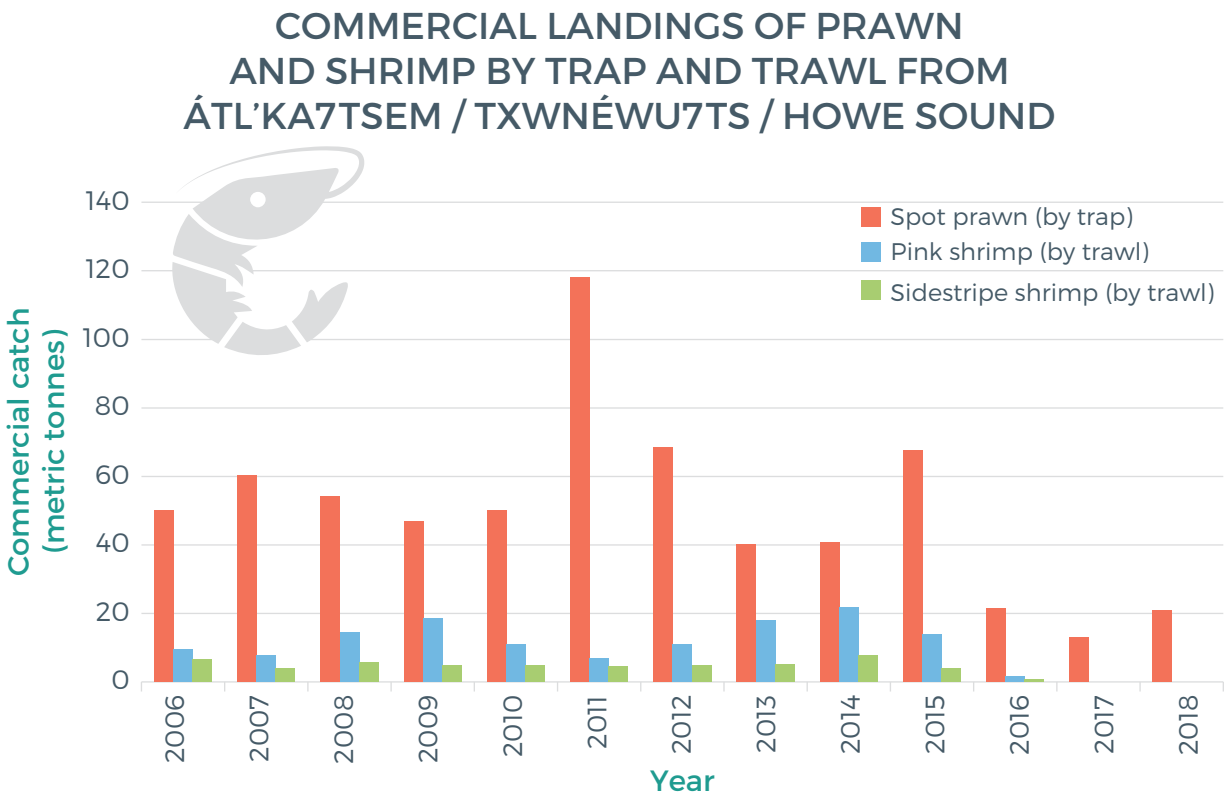

Figure 1. 2006–2018 Commercial catch (tonnes) of prawn and shrimp by trap and trawl methods from Átl'ka7tsem/Txwnéwu7ts/Howe Sound.

Spot prawn (*Pandalus platyceros*). (Credit: Maxwell Hohn)

Sidestripe shrimp stock size was estimated to be above the Upper Stock Reference (USR)[ii] and in the healthy zone[ii].[5,6] When either pink or sidestripe shrimp stocks fall into the critical zone, no harvesting is allowed for either species due to the difficulty of species-specific targeting using trawl gear.

In 2017, as a result of pink shrimp being in the critical zone, the shrimp fishery using bottom trawl methods was closed and has remained closed (Figure 1).[5,6] As of 2019, pink shrimp stocks for the Fraser River SMA are still in the critical zone.[2] The estimated sidestripe stock biomass has decreased from ~153.5 t in 2018 to ~123.1 t in 2019, now falling below the USR and into the cautious zone[iii].[2] For stocks in the healthy zone, a 35% catch rate of total estimated biomass is set; for the cautious zone, a declining catch rate is set based on proximity to the LRP[iv]. For the critical zone, a 0% catch rate is set.[7]

The status of prawn stock size is monitored during the commercial trap fishery that occurs during May and June. When numbers of breeding females approach or reach the management target, the trap fishery closes for the season.[3] The management target is akin to a USR; therefore prawn stocks are considered to be in the healthy zone. DFO conducts a post-season prawn stock survey in November each year. The recreation-

ii) Healthy zone – stock status is above the Upper Stock Reference (USR); USR = ~80% of estimated sustainable yield.

iii) Cautious zone – stock status falls between LRP and USR.

iv) Limit Reference Point – the LRP is the stock size delineating the cautious and the critical zones.

al prawn trap fishery is open all year; however, if the number of breeding females drops below target based on the November survey, portions of Átl'ka7tsem/Txwnéwu7ts/Howe Sound are closed to fishing for the remainder of the recreational fishing season.

In addition to fisheries closures, other government efforts to increase the sustainability of shrimp trawl and prawn trap fisheries include:

- Improved technology, gear and bait. Increased recreational participation in recent years has led to discussions with DFO and the Sport Fishing Advisory Board on decreasing the daily recreational catch limit for prawns.[3] As of April 2020, the recreational prawn daily catch limit reduced to 125[v].
- The semi-annual DFO survey of prawn stocks in Átl'ka7tsem/Txwnéwu7ts/Howe Sound continued in February and November 2016, 2017 and 2018.[3] This study commenced in 1985 and contributes to a long-term data set of valuable information on the fluctuating prawn stock status in Átl'ka7tsem/Txwnéwu7ts/Howe Sound. Current reports do not mention 2019, and no data are available.
- Any interactions between commercial fishers and marine mammals is now required to be reported, including accidental drowning, bycatch, entanglements, collisions and fatalities.[2,4] This can be done via the Marine Mammal Incident Hotline (1-800-465-4336).

Bycatch is inevitable with trap and trawl fisheries and is a significant issue throughout the world's oceans. Programs to minimize bycatch include increased bycatch monitoring by observers, area closures and seasonal closures. There were 18 fishery-independent at-sea observers deployed for the 2018 prawn trap fishing season along the B.C. coast.[3] These observers undertake sampling, which helps with decision-making related to in-season closures, as well as assisting with enforcement. As was reported in Ocean Watch Howe Sound Edition (OWHS) 2017, 80% of the total commercial fleet was checked for compliance during the fishing season throughout the B.C. coast.[3] Bycatch reduction devices[vi] for trawl nets are also mandatory throughout the Pacific Northwest.

Extra concern surrounds Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed species within the B.C. shrimp trawl and prawn trap fisheries. Eulachon bycatch in the shrimp trawl fishery and some species of rockfish in the prawn trap fishery are a concern.[4,8] As mentioned previously (see Prawn and Shrimp Fisheries, OWHS 2017), Rockfish Conservation Areas are closed to trawl fishing but open to commercial and recreational prawn trap fishing (see

Checking for eggs. (Credit: Maxwell Hohn)

v) Recreational catch limits listed here: www.pac.dfo-mpo.gc.ca/fm-gp/rec/tidal-maree/a-s28-eng.html.

vi) Bycatch reduction devices are used to reduce the amount of non-target species caught.

Marine Protected Areas, OWHS 2017). The number of juvenile rockfish caught as bycatch varies annually. Although rockfish mortality by the prawn trap fishery is considered low relative to all other sources of mortality, the commercial prawn industry is proactively working to reduce bycatch mortality.

One way to reduce mortality of bycatch is by using devices called rockfish descenders. They have been shown to be very effective at reducing barotrauma[vii] by allowing the rockfish to quickly be lowered back down and released at the depth they were caught. From April 1, 2019, recreational fishers are now required to use these devices.[9] The commercial prawn industry will be encouraged to start using descenders, particularly for the COSEWIC-listed Quillback (*Sebastes maliger*) and Yelloweye (*S. reuberrimus*) species in the 2020 season.

Overall, Rockfish Conservation Areas and the activities permitted in them are under review. Rockfish Conservation Areas, sponge reef closures and no take zones are distributed throughout Átl'ka7tsem/Txwnéwu7ts/Howe Sound (Figure 2).

What are the potential impacts of climate change on these fisheries?

Shrimp and other crustaceans are at medium risk from climate change largely due to their low mobility, meaning they are less able to move to more suitable areas, and their high dependency on environmental conditions for their life cycle.[10,11] However, predicting the specific impact of climate change to prawn and shrimp stocks within Átl'ka7tsem/Txwnéwu7ts/Howe Sound and the Strait of Georgia is difficult.

Shrimp populations off the west coast of B.C. have been seen to decrease in number with increasing sea surface temperatures,[12] suggesting they prefer cooler water. Growth rates of similar shrimp species to those mentioned here have been closely linked with water temperature, with faster growth rates observed in cooler temperatures.[13] As water temperature increases, possible negative impacts on a variety of functions may be seen, including a reduction in the number of reproducing females, growth rates, developmental rates, egg production and larval survival of spot prawns.[11,13] Thus, any increase in water temperature may be detrimental to shrimp and prawn size and stocks. Pink shrimp species are also experiencing a northward range expansion in the Canadian Pacific because of ocean warming.[14] Additionally, more acidic conditions have been shown to result in delayed development of juvenile spiny pink shrimp.[15]

vii) Barotrauma – injury related to changes in pressure, caused by ascending too quickly to the water's surface.

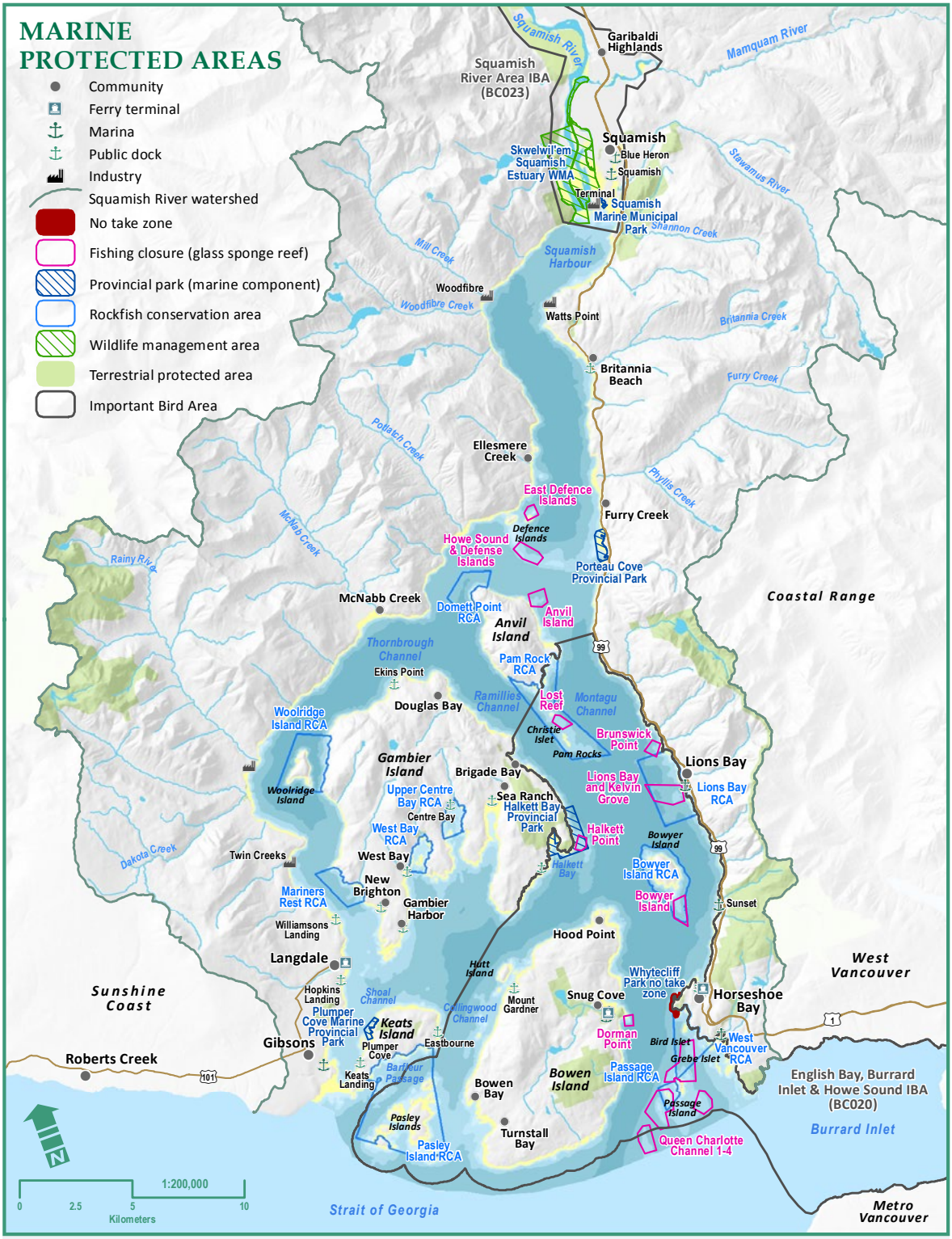

Figure 2. Rockfish conservation areas, glass sponge reefs and sponge reef fishing closures within Átl'ka7tsem/Txwnéwu7ts/Howe Sound.[16]

What has been done since 2017?

The table below reports on progress made on recommended actions from the previous 2017 article, where identified. Many of these require ongoing action.

2017 ACTION	ACTION TAKEN
INDIVIDUAL AND ORGANIZATION ACTIONS	
Use "rot cords" (a biodegradable escape mechanism) on your traps to allow bycatch to escape in the event traps are lost.	An amendment to the B.C. Sport Fishing Regulations will likely soon require a biodegradable escape mechanism, or "rot cord," on all recreational prawn and crab traps, allowing bycatch to escape.
Make sure your buoys are clearly identified with your name.	This is now mandatory, along with a phone number or unique Fisher Identification Number (FIN). DFO is working towards adopting standardized buoys. Talks continue in 2019, in consultation with the Sports Fishing Advisory Board. When adopted, this will eliminate the use of Styrofoam and other plastic containers that break down and contribute to ocean plastic pollution.
Release prawns and shrimp that are carrying eggs under their tails (known as berried prawn and shrimp) as soon as possible at the fishing location.	As of April 2018, prawns with eggs are no longer allowed to be kept. This is in addition to seasonal closures in some areas during critical spawning and larval hatching times (January 1 to March 31).[3]

2017 ACTION	ACTION TAKEN
GOVERNMENT ACTIONS AND POLICY	
Expand sponge reef closures to include all sponge reefs and bioherms identified in Átl'ka7tsem/ Txwnéwu7ts/Howe Sound, in accordance with the Sensitive Benthic Areas Policy.	The previous report detailed nine glass sponge reef areas where bottom contact fishing was prohibited (as of 2015) (see Prawn and Shrimp Fisheries, OWHS 2017). In March 2019, DFO formed eight marine refuge areas to encompass the nine additional glass sponge reefs placed under voluntary protection in 2017.[3] DFO Fishery closures were implemented, which included all fishing activities likely to damage the reefs, including fishing activities for shrimp and prawn. Nine additional glass sponge reef areas in Átl'ka7tsem/Txwnéwu7ts/Howe Sound still require verification in order to determine their ecological importance.
Allocate more resources to enforcement of fishing regulations, including protected area closures.	The Pacific Prawn Fishermen's Association (PPFA) provides funding annually to DFO for enhanced enforcement; in 2018, $29,000 was provided. At-sea observers in the prawn trap fishery conducted gear inspections and licence compliance checks (i.e., trap tagging, trap mesh size, buoy identification and logbook completion) on 80% of active vessels during the 2018 season along the B.C. coast.[2] Currently, DFO lists the investigation of illegal prawn sales as a top enforcement priority.[3] The PPFA received funding support to purchase and supply every commercial prawn vessel with a rockfish descender for the 2020 season.

What can you do?

A detailed overview of recommended actions relating to climate change is included in *The path to zero carbon municipalities* (OWHS 2020). In some cases, no progress was identified on previous recommended actions; these remain listed below. Additional actions marked as NEW also follow.

Individual and Organization Actions:

- Make sure your licence is up to date and comply with catch limits when you are sport fishing.
- Keep your traps away from sensitive areas including sponge reefs, bioherms, and RCAs.
- Release live catch (i.e. bycatch) in waters where caught.
- Report any gear theft and the theft of catch from traps to the police.
- Report accurate fishing activity and catch to DFO when requested to do so.
- NEW Carry a rockfish descender when fishing within Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound, and if accidental bycatch of rockfish occurs, make sure to release it back to the depth caught within two minutes.
- NEW Choose to buy Ocean Wise recommended shrimp and prawn.

Government Actions and Policy:

- NEW Verify the remaining glass sponge reefs and set up marine refugia and associated fisheries closures.
- NEW Establish citizen enforcement officers throughout the Sound, who are granted limited enforcement powers, such as checking catch size, species, and fishing method, and handing out fines for fisheries infringements.

Methods

Information and data were obtained from the DFO website (i.e., fishery notices, Integrated Fisheries Management Plans,[3-6] Sport Fishing Guides); from personal communication with DFO staff who provided Shrimp Survey Bulletins[2] and unpublished data; and from members of the Pacific Prawn Fishermen's Association.

PRE-SEASON FORECASTS

A five-year running average model is used to forecast shrimp stock size within SMAs with ongoing surveys. This is used to set an initial catch ceiling, which can then be modified with data collected from in-season surveys. SMAs with no survey history have catch ceil-

ings calculated from 10th or 25th percentile[viii] of the pre-1997 catch history.[3]

IN-SEASON SURVEYS

DFO monitors prawn trap fishing vessels in real time and uses this information to deploy at-sea-observers. In the 2018 season, 186 of the 205 active fishing vessels were sampled coast wide. This equated to a total of 2,177 strings, 54.4 strings/fishery day, and a total of 468 person-days of direct monitoring. Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound has been identified as one of the priority areas of interest, and therefore sampling commences early. The commercial fishery for prawns in Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound in 2018 lasted 36 days, with portions of the area closed earlier based on sampling. In 2018, Pacific Fishery Management Area subarea 28-2 in Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound closed after 12 days, 28-3 after 26 days, 28-1 after 29 days and 28-4,5 after 36 days.[17] Coastwide, the longest an area was open for was 40 days in 2018. In-season closures of subareas are implemented on three days' notice.[3,4]

References

1 Ocean Wise Conservation Association. Ocean Wise seafood program [Internet]. 2019. Available from: https://seafood.ocean.org/seafood/type/shrimpprawns/

2 Fisheries and Oceans Canada (DFO). Shrimp survey bulletin 19-02, Fraser River SMA. 2019;6.

3 Fisheries and Oceans Canada. Pacific Region Integrated Fisheries Management Plan: Prawn and Shrimp By Trap. 2019;1–100.

4 Fisheries and Oceans Canada (DFO). Pacific Region Integrated Fisheries Management Plan – Euphausids. Fish Manag. 2019;46.

5 Fisheries and Oceans Canada (DFO). Pacific Region Integrated Fisheries Management Plan: Prawn and Shrimp By Trap. 2018;1–100.

6 Fisheries and Oceans Canada (DFO). Pacific Region Integrated Fisheries Management Plan – Euphausids. Fish Manag. 2018;46.

7 Fisheries and Oceans Canada (DFO). Assessment of inshore shrimp stocks along the coast of British Columbia, 2011. Can Sci Advis Secr Sci Advis Rep [Internet]. 2012;12. Available from: https://waves-vagues.dfo-mpo.gc.ca/Library/346396.pdf

8 Rutherford D, Fong K, Nguyen H. Rockfish bycatch in the British Columbia commercial prawn trap fishery. Can Sci Advis Secr Sci Advis Rep. 2010;

9 Fisheries and Oceans Canada (DFO). Recreational fishery notice [Internet]. 2019. Available from: https://notices.dfo-mpo.gc.ca/fns-sap/index-eng.cfm?pg=view_notice&DOC_ID=220071&ID=all&fbclid=IwAR0k8zxz0-1upWeyzU53xzT6JJnxp9vqI7H5CGwaIpcJWcUuTo_TizSK7Ts

10 Hunter KL, Gillespie KM, Brydges TM, Irvine JR. Preliminary assessment of the sensitivity of West Coast Vancouver Island marine species to climate change. Can Manuscr Rep Fish Aquat Sci. 2014;3036:87.

11 Talloni-Álvarez NE, Sumaila UR, Billon PL, Cheung WWL. Climate change impact on Canada's Pacific marine ecosystem: The current state of knowledge. Mar Policy. 2019;104:163–76.

12 Perry RI, Fong K, Waddell B, Rutherford D. Small-mesh bottom-trawl surveys west of Vancouver Island: update for 2013. In: State of the physical, biological and selected fishery resources of Pacific Canadian marine ecosystems in 2013. 2014.

13 Hunter KL, Wade J. Pacific large aquatic basin climate change impacts, vulnerabilities and opportunities assessment – marine species and aquaculture. Vol. 3049, Can. Man. Rep. Fish. Aquat. Sci. 2015. viii + 242 pp.

14 Okey TA, Alidina HM, Jessen S. Effects of climate change on Canada's Pacific marine ecosystems: a summary of scientific knowledge. Rev Fish Biol Fish. 2014;24:519–59.

15 Haigh D, Ianson D, Holt CA, Neate HE, Edwards AM. Effects of ocean acidification on temperate coastal marine ecosystems and fisheries in the northeast Pacific. PLoS One. 2015;10:e0117533.

16 Beaty F, van Riet W, Wareham B, Schultz J. Atl'ḵa7tsem/Howe Sound Marine Conservation Assessment [Internet]. Available from: http://howesoundconservation.ca

17 Fisheries and Oceans Canada (DFO). Prawn fishing area openings and closures, 2018 – commercial fishery. In 2018.

viii) 10th percentile – larger than 10% of the datapoints; 25th percentile – larger than 25% of the datapoints.