Summary of Snow Crab Workshop

St. John's, Newfoundland, Canada

April 29 – May 2, 2024

Organized by BSFRF and DFO with 41 participants from Canada (12 DFO, 9 MUN), US (7 BSRF, 5 NOAA, 3 ADF&G), Norway, Denmark and France

Publication:

Kruse, G.H., R. Ruiz-Diaz, T. Loher, and B.J. Daly. 2025. Report of the 2024 snow crab workshop: Clawing their way back; A comparative Newfoundland – Alaska workshop toward sustainable management in uncertain times. Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries, Special Publication 25-11, Anchorage.
https://www.adfg.alaska.gov/FedAidPDFs/SP25-11.pdf

Organization of Talks

1. Physical ecosystem dynamics, ecosystem approaches, and linkages
2. Exploratory population modeling
3. Applied management

Main Emerging Themes

1. Role of climate on snow crab productivity
2. Other ecosystem factors affecting snow crab
3. Fishing effects on stock reproductive health and size at maturity

Role of Climate on Ecosystem Productivity

- Snow crab is an Arctic species thriving in cold water. Survival of young crab depends on the cold intermediate layer (CIL) in Newfoundland & Labrador (NL) and cold pool (EBS). Interestingly, warm temperatures promote the growth of adult snow crab.
- Cold water serves as a refuge for young crab.
- Sea ice promotes nutritious ice-related phytoplankton blooms.
- Historically, EBS and NL snow crab have covaried. However, since 2020, the correlation broke down owing to the collapse of the EBS stock and the sustained strong performance of NL stock.

Role of Climate on Ecosystem Productivity

- Collapse of EBS snow crab over 2018-2021 was attributed to starvation associated with a marine heat wave, that led to high metabolic demand, coupled to high densities of mature crab.
- NL snow crab varies opposite the southern Gulf of St. Lawrence (sGSL) stock depending on the North Atlantic Oscillation (NAO). Positive-phase NAO leads to stronger southward-flowing Labrador Current (LC) and a cooler eastern NL shelf, whereas NAO relaxation allows more cold LC to flow past the Grand Banks and into the sGSL
- As a result, extent of the CIL in NL versus sGSL depends on the strength and phase of the NAO.

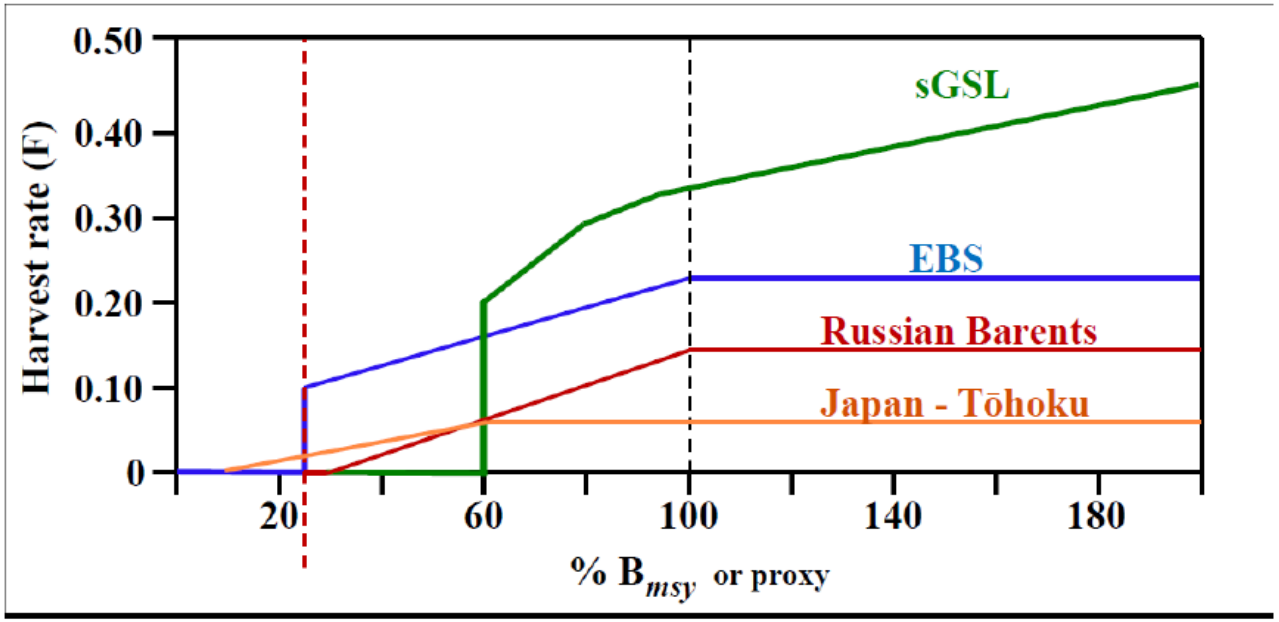
Other Ecological Factors affecting Snow Crab

- Snow crab are common in cod stomachs in both the North Pacific and North Atlantic. However, while some research has implicated cod in snow crab declines, most failed to detect a predation effect in the EBS, NL and sGSL.
- One NL study suggested that cod predation of crab could be deemed more of a crab recruitment index than a mortality indicator, particularly given that cod regularly consume a size range of crab not well sampled by survey trawls.
- Predation is an area of ongoing research.

Other Ecological Factors affecting Snow Crab

- Bitter crab disease (BCD) is a parasitic infection that gives crab a bitter taste and renders infected crab as unmarketable. It occurs in both North Pacific and North Atlantic snow crab.
- Modern methods sample hemolymph with greater accuracy than former visual methods that tend to underestimate infection prevalence. In the EBS, there was a dramatic increase in BCD (up to 70% in the NBS) over 2015-2017, raising the questions about potential involvement in recent snow crab declines. Because of imprecision of older visual methods, it is not possible to infer long-term trends in BCD prevalence.

Regional Exploit. Rates (Apples to Oranges)



sGSL = ≥ 95mm CW males

EBS = "Morphometrically mature" males according to chela height

Barents = ≥ 100mm CW males

Tōhoku :specifies rates within three categories:

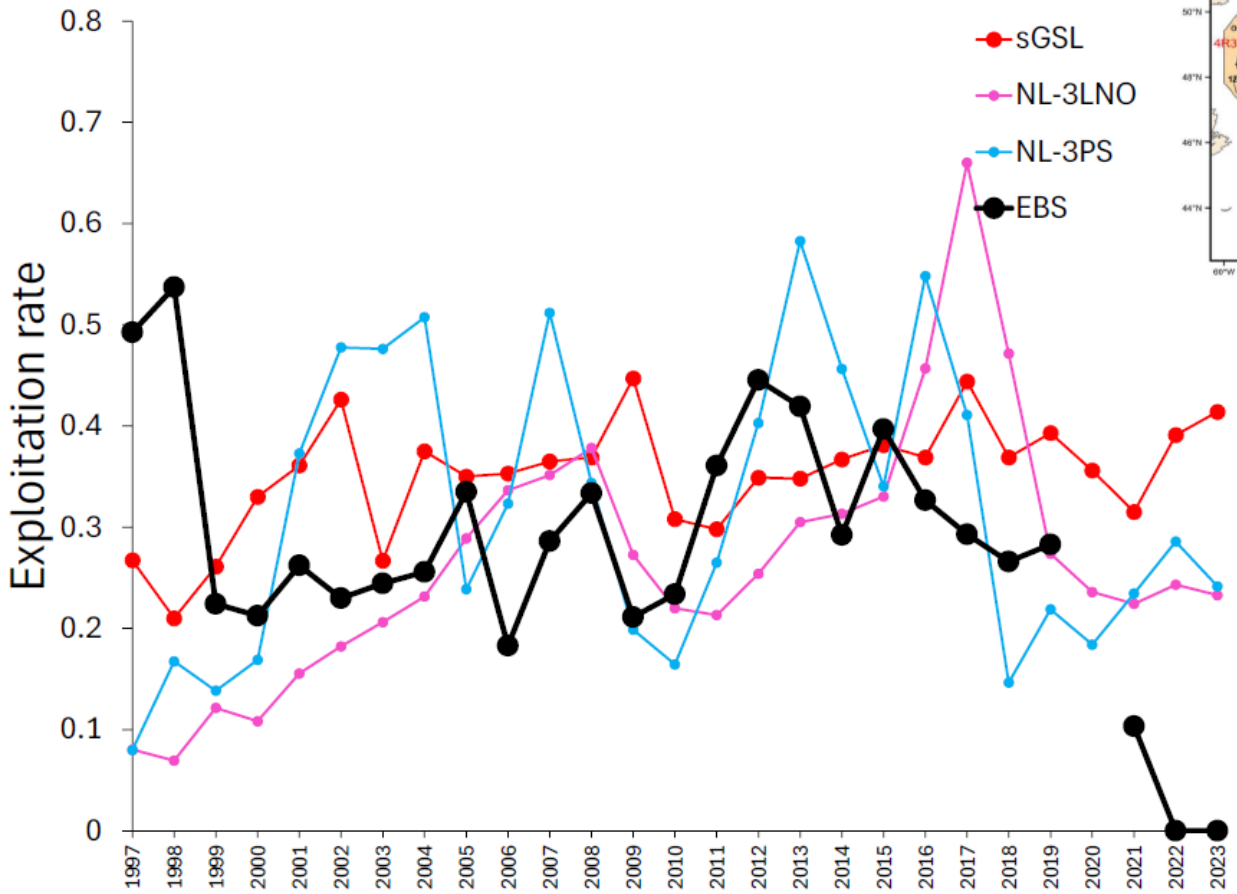
1) ≥ 80mm immature males (Fmax = 0.05)
2) morphometrically-mature males (Fmax = 0.05)
3) terminal molt females (Fmax = 0.01)

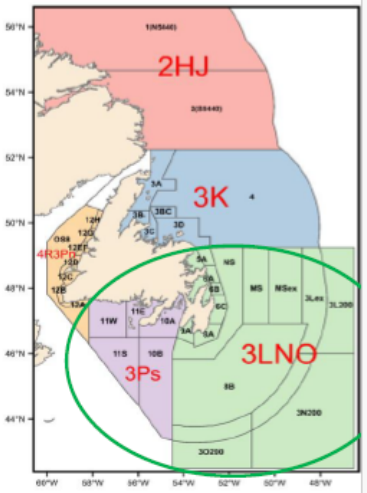
From Ben Daly

Regional Exploit. Rates (Apples to Apples)

- When harvest control rules are expressed using the same “apples-to-apples” metrics (i.e., biomass of males ≥95 mm or 3.74 inches CW), historical exploitation rates applied in the EBS are similar to those in the sGSL and NAFO Divisions 3Ps and 3LNO, but somewhat lower than those used in NAFO Divisions 3K and 2HJ

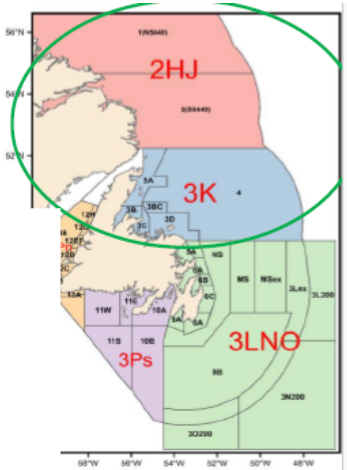
Apples to Apples comparison: ≥95 mm biomass

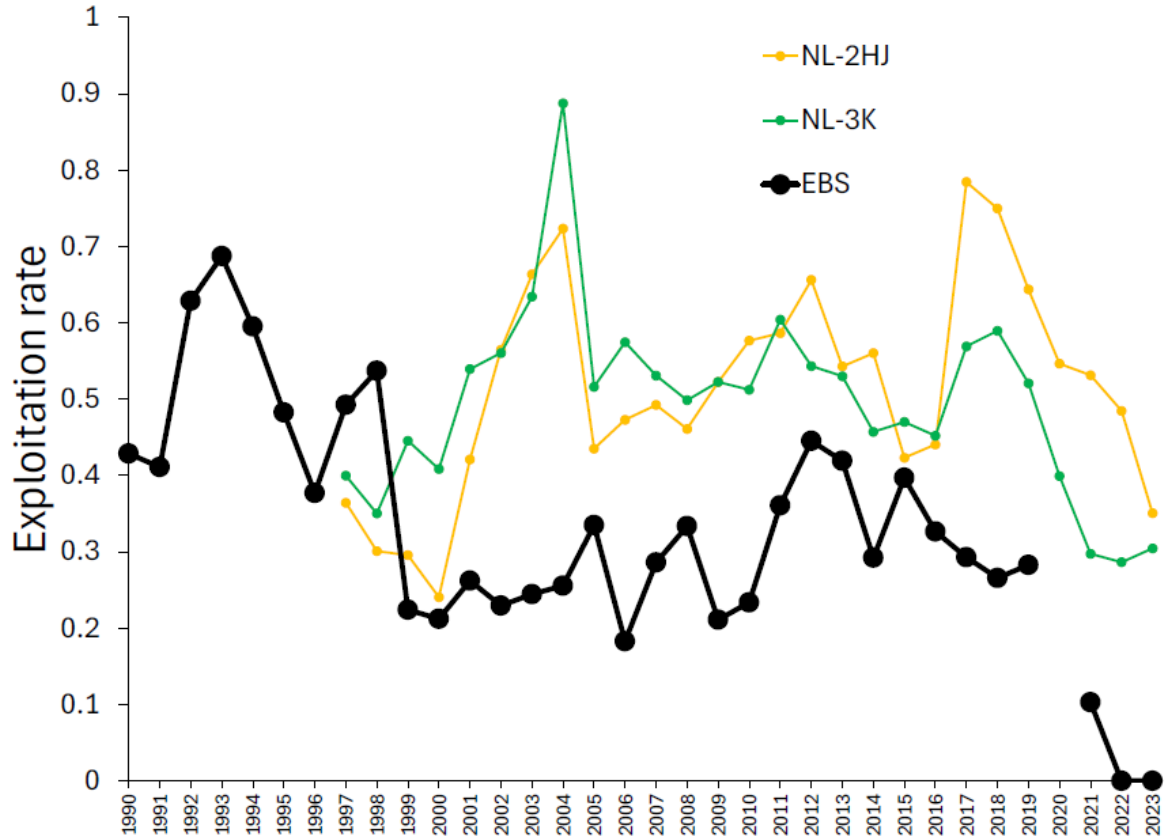




From Ben Daly

Apples to Apples comparison: ≥95 mm biomass





From Ben Daly

Fishing Effects on Stock Reproductive Health and Size of Maturity

- EBS male snow crab have experienced a long-term decline in size at 50% maturity since 2006, but the causes have not been investigated.
- Similar downward shifts in size of maturity in the NL region were attributed to cold conditions and low crab densities resulting from elevated exploitation rates.

Fishing Effects on Stock Reproductive Health and Size of Maturity

- The mechanism linking higher harvest rates to lower size at maturity involves competition for mates. Large males outcompete small ones for mating. Large males deliver larger sperm loads to fertilize large egg clutches. When densities of large males are high, small immature males tend to continue growing to reach larger sizes associated with successful reproduction. However, when large males are removed by high exploitation rates, small males undergo terminal molt to maturity sooner as they no longer need to compete with large males for mates.

Fishing Effects on Stock Reproductive Health and Size of Maturity

- The problem with mating by small male snow crab is that they are less competent in mating and multiple small mates may be required for the female to acquire sufficient sperm to fertilize full clutches. Also, mating with multiple smaller males cause females to suffer more injuries during mating, which can be fatal.
- In general, female clutch fullness is higher in NL than EBS snow crab; e.g., in 2022 just 37% of mature females in the EBS had clutch fullness of 75% full or greater, the lowest on record dating back to 1980.

Fishing Effects on Stock Reproductive Health and Size of Maturity

- In NL in the late 2010s, exploitation rates were allowed to increase to high levels across the entire stock range associated with a large resource decline.
- In 2019 when stock and fishery productivity were near historical lows, a Precautionary Approach (PA) was put into place in fishery management.
- Under the PA, harvest control rules are based on estimated biomass as well as stock health scores based on: (1) predicted fishery CPUE, (2) predicted discards, and (3) female egg clutch size.

Fishing Effects on Stock Reproductive Health and Size of Maturity

- The primary harvest control rules in the PA allow for up to 42%, 35%, and 20% exploitation rates, with no lower bounds, when the stock is categorized to be in healthy, cautious, and critical zones, respectively.
- Since implementation of the PA, NL snow crab stocks have responded very favorably. Discards became low, clutch fullness became high, and CPUE became high. Also, importantly, size at maturity, which had previously declined, turned around and increased.

Research Recommendations

- Strengthening future collaborative research.
- Further work on indices of stock reproductive health including changes in size at maturity related to harvest rates and temperature.
- Appropriate size limits in light of size at maturity.
- Management strategy evaluation for the EBS stock.

Research Recommendations

- Lab studies of crab physiology with respect to temperatures experienced during the 2018-2021 EBS marine heat wave.
- ID critical habitats (e.g., nursery areas).
- Effects of “pelagic” trawls on crabs.
- Ghost fishing of lost crab pots.
- Gear research to reduce bycatch.

→ See report for full list of recommended research.