Birds on Floating Culture, Oh My!

BOBBI HUDSON, DIRECTOR, PACIFIC SHELLFISH INSTITUTE (PSI)

NSA 115TH ANNUAL MEETING
MARCH 26-30, 2023, IN BALTIMORE, MARYLAND

Presentation Outline

- How did we get here?
- Public health response assumptions
- What we know: birds, fecal coliform & human health risk
- Floating gear occurs in very different environments (tidal amplitude, water flow, etc.)
- Current mitigation strategies & the unknowns
- Conclusions

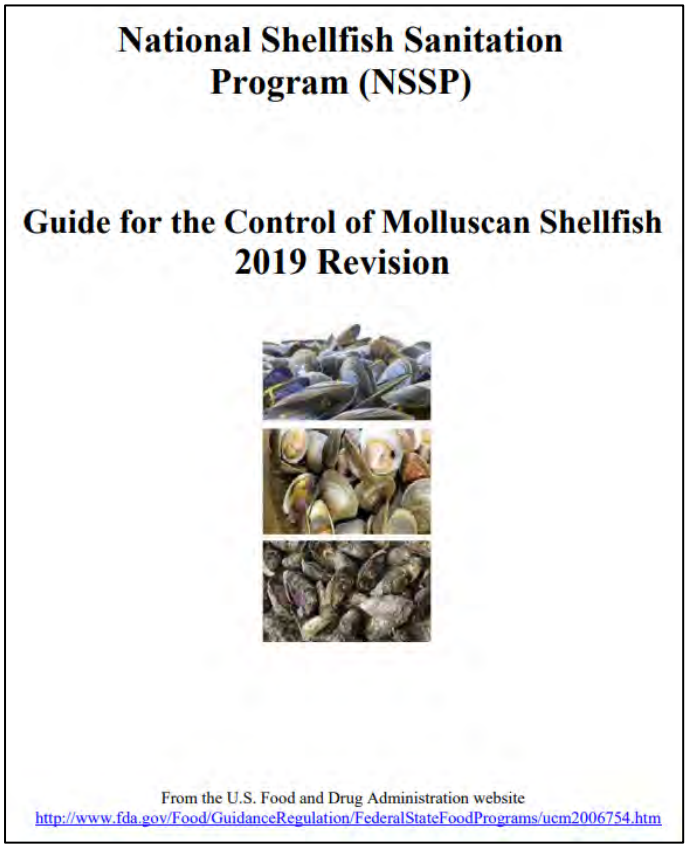

Photo by A. Munro

Chapter VI Requirements for the Harvester/Dealer

.04 Aquaculture That Attracts Birds or Mammals

A. Operational Plan

Each aquaculture site that the Authority determines may attract sufficient birds and/or mammals that their waste ***presents a human health risk*** shall have a written operational plan.

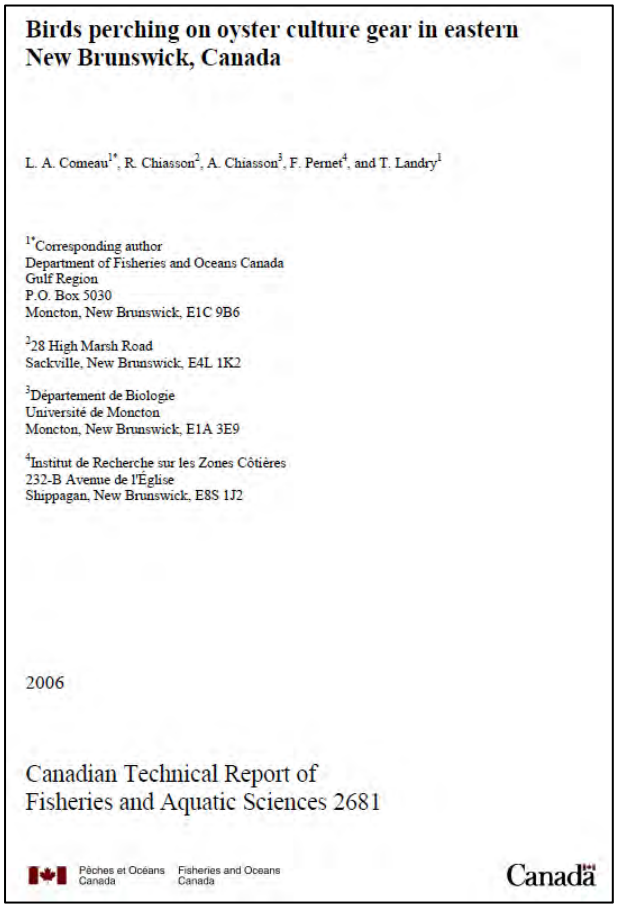


How did we get here?

During routine sampling in Sept. 2004, Canadian Food Inspection Agency (CFIA) noticed presence of bird fecal matter on floating bags containing market-size oysters, a situation that was ***deemed to be an unacceptable human health risk***.

Some oyster samples were found to exceed the standard for fecal coliforms and all oyster suspended culture sites situated in the waters of eastern N.B. were immediately closed to harvesting.

Resulted in the near total shut down of all oyster production for ~150 sites.



Birds perching on oyster culture gear in eastern New Brunswick, Canada

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2006

Canadian Technical Report of
Fisheries and Aquatic Sciences 2681

Pêches et Océans Canada | Fisheries and Oceans Canada

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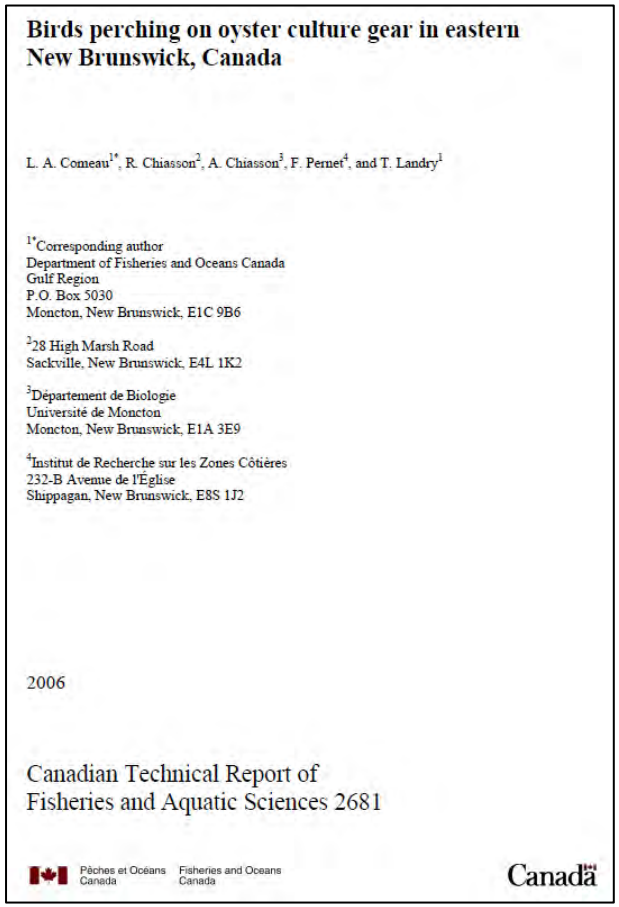
New Brunswick Results

We caution that bird counts were carried out within farms and consequently that ***there were many other co-factors which may explain our results***.

For example, nearby nesting habitat and feeding areas are likely other explanatory factors for the reported differences in bird density.

Together these observations suggest that the ***oyster gear was not the main factor attracting birds into a given area***.



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ELSEVIER

Aquacultural Engineering

Volume 40, Issue 2, March 2009, Pages 87-94

Deterring coastal birds from roosting on oyster culture gear in eastern New Brunswick, Canada

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https://doi.org/10.1016/j.aquaeng.2008.11.003 Get rights and content

Abstract

An ornithological survey was conducted along the eastern coastline of New Brunswick, Canada, where oysters are cultivated in suspension using PVC bags and wire-mesh cages. Thirteen bird species and a variety of unidentified shorebirds were observed roosting on the floating oyster gear. The double-crested cormorant (*Phalacrocorax auritus*) was the most common species observed (47.6% of all counts), closely followed by herring gulls (*Larus argentatus*) and common terns (*Sterna hirundo*) at 18.7% and 13.0%, respectively. Birds were densely aggregated where few cages or bags had been deployed. A gear-type effect was also detected: birds were more abundant on floating cages (mean = 47.9/100 m^2 of exposed

Similar Response in NY, USA

2016: 1st closure of shellfish aquaculture sites in New York due to excessive bacterial contamination

Two consecutive years of shellfish closures due to FC contamination & E. coli in shellfish meats

No potential contamination sources identified other than significant seabird roosting/perching on oyster culture gear

2018: Bird Mitigation Plans required for permits with floating gear; applies to existing and new permits

NEW YORK STATE OF OPPORTUNITY Department of Environmental Conservation

Source: NE Shellfish Sanitation Assoc. Meeting April 9-10, 2019

Public Health Response

Public health response **assumes** birds on floating oyster culture creates:

1. Localized fecal coliform accumulation
2. Fecal coliform will be uptake by filter feeding oysters
3. The fecal coliform will carry pathogens of human health concern

Source: Social media image accessed at www.facebook.com/fannybayoysters/photos

1. Localized fecal coliform (FC) accumulation?

Sometimes. It depends on:

1. Bird numbers
2. Bird species/size
3. Season
4. Temperature
5. Salinity
6. Current
7. Tidal exchange
8. Oyster container type

Photo by A. Munro

2. FC will be uptake by filter feeding oysters?

Sometimes. It depends on:

1. Season
2. Temperature
3. Salinity
4. Current
5. Tidal exchange
6. Oyster container type
7. Age of oyster

Source: Social media image accessed at www.facebook.com/fannybayoysters/photos

3. FC will carry pathogens of human health concern?

- Avian feces contaminate waterways but contribute fewer human pathogens than human sources.
- Although pathogens occur in bird feces, exposure to bird feces is considered less harmful to humans than exposure to other sources of fecal contaminants, especially that of humans.
- For example, molecular evidence indicates that genotypes of certain parasites in birds, such as Giardia and Cryptosporidium, are host adapted and cannot cross-infect among different hosts.
- The relative human health risks of bird and human fecal contamination will be more amenable to measurement once reliable methods are developed to distinguish them quantitatively.

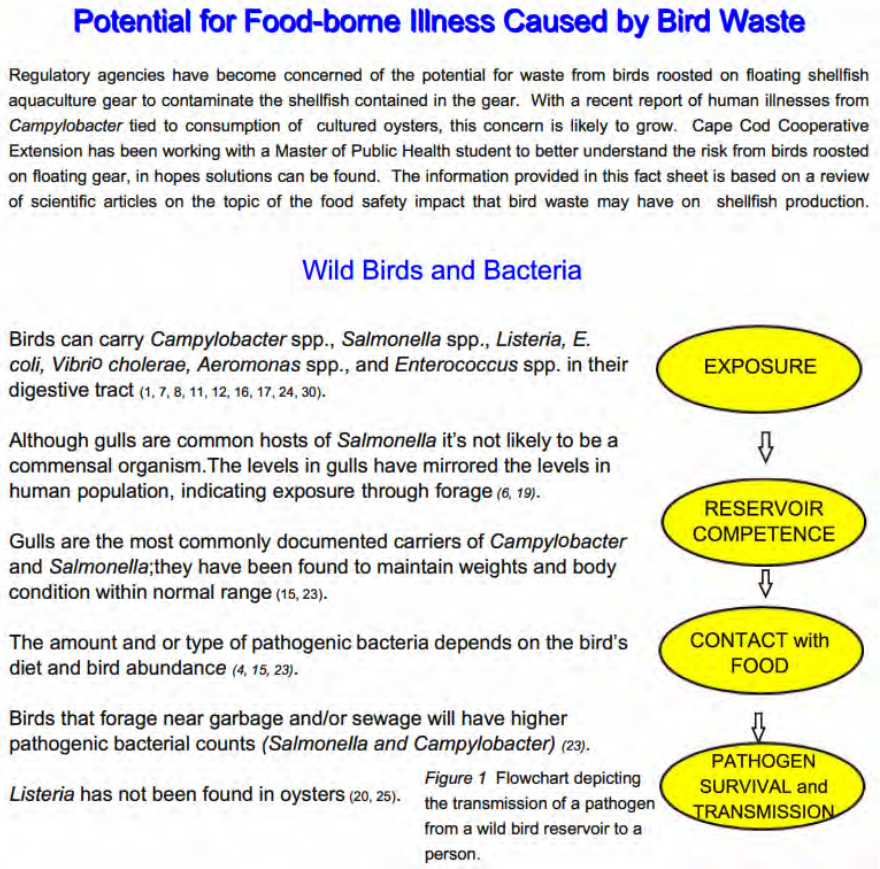
Green HC, Dick LK, Gilpin B, Samadpour M, Field KG. 2012. Genetic markers for rapid PCR-based identification of gull, Canada goose, duck, and chicken fecal contamination in water. Appl Environ Microbiol.78(2):503-10.

Pathogenic Bacteria

Depends on the amount and type, the bird's diet and bird abundance.

Birds that forage near garbage and/or sewage will have higher pathogenic bacterial counts (Salmonella and Campylobacter).

"Fact Sheet on Potential for Food-Borne Illness Caused by Bird Waste" from Cape Cod Cooperative Extension (CCE) https://x5qefe.p3cdn1.secureserver.net/wp-content/uploads/2022/06/Fact-Sheet-bird-risks.pdf



Potential for Food-borne Illness Caused by Bird Waste

Regulatory agencies have become concerned of the potential for waste from birds roosted on floating shellfish aquaculture gear to contaminate the shellfish contained in the gear. With a recent report of human illnesses from *Campylobacter* tied to consumption of cultured oysters, this concern is likely to grow. Cape Cod Cooperative Extension has been working with a Master of Public Health student to better understand the risk from birds roosted on floating gear, in hopes solutions can be found. The information provided in this fact sheet is based on a review of scientific articles on the topic of the food safety impact that bird waste may have on shellfish production.

Wild Birds and Bacteria

Birds can carry *Campylobacter* spp., *Salmonella* spp., *Listeria, E. coli, Vibrio cholerae, Aeromonas* spp., and *Enterococcus* spp. in their digestive tract (1, 7, 8, 11, 12, 16, 17, 24, 30).

Although gulls are common hosts of *Salmonella* it's not likely to be a commensal organism.The levels in gulls have mirrored the levels in human population, indicating exposure through forage *(6, 19)*.

Gulls are the most commonly documented carriers of *Campylobacter* and *Salmonella*;they have been found to maintain weights and body condition within normal range (15, 23).

The amount and or type of pathogenic bacteria depends on the bird's diet and bird abundance *(4, 15, 23)*.

Birds that forage near garbage and/or sewage will have higher pathogenic bacterial counts *(Salmonella and Campylobacter)* *(23)*.

Listeria has not been found in oysters (20, 25).

EXPOSURE → RESERVOIR COMPETENCE → CONTACT with FOOD → PATHOGEN SURVIVAL and TRANSMISSION

Figure 1 Flowchart depicting the transmission of a pathogen from a wild bird reservoir to a person.

Let's talk about risk…

1. **Data are too limited and biased** currently to make any data-driven recommendations for managing wild birds to reduce enteric pathogen spillover to people. Current evidence suggests wild birds are often poor reservoir hosts of human strains.
2. Experiments determining the long-term shedding potential of enteric pathogens by wild birds are crucial.
3. Studies must quantify contact rates, direct and indirect, in developing risk assessments.

BIOLOGICAL REVIEWS
Cambridge Philosophical Society
Biol. Rev. (2020), **95**, pp. 652–679.
doi: 10.1111/brv.12581

Are we overestimating risk of enteric pathogen spillover from wild birds to humans?

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Molecular Detection of *Campylobacter* spp. in California Gull (*Larus californicus*) Excreta

Jingrang Lu[1,*], Hodon Ryu[2], Jorge W. Santo Domingo[2], John F. Griffith[3], Nicholas Ashbolt[1]

[1]National Exposure Research Laboratory, U.S. EPA, Cincinnati, Ohio
[2]National Risk Management Research Laboratory, U.S. EPA, Cincinnati, Ohio
[3]Southern California Coastal Water Research Project, Costa Mesa, California

ABSTRACT We examined the prevalence, quantity, and diversity of *Campylobacter* species in the excreta of 159 California gull (*Larus californicus*) samples using culture-, PCR-, and quantitative PCR (qPCR)-based detection assays. *Campylobacter* prevalence and abundance were relatively high in the gull excreta examined; however, *C. jejuni* and *C. lari* were detected in fewer than 2% of the isolates and DNA extracts from the fecal samples that tested positive. Moreover, molecular and sequencing data indicated that most *L. californicus* campylobacters were novel (<97% 16S rRNA gene sequence identity to known *Campylobacter* species) and not closely related to species commonly associated with human illness. *Campylobacter* estimates were positively related with those of fecal indicators, including a gull fecal marker based on the *Catellicoccus marimammalium* 16S rRNA gene.

Journal of Food Protection, Vol. 55, No. 8, Pages 649-656 (August 1992)

Nonpoint Pollution From Animal Sources and Shellfish Sanitation

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(Received for publication September 9, 1991)

ABSTRACT

Many of the microorganisms pathogenic to both animals and man are transmitted via the fecal-oral route. Most of these pathogens could conceivably be transmitted through a shellfish vector. Bacteria potentially transmitted from animal to man via shellfish include most of the salmonellae, *Yersinia enterocolitica*, *Yersinia pseudotuberculosis*, *Escherichia coli* O157:H7, *Campylobacter jejuni*, and *Listeria monocytogenes*. The protozoa most likely to be transmitted this way are *Giardia lamblia* and *Cryptosporidium* spp. Because the enteric viruses are highly species-specific, they are not likely to be transmitted from animals to humans. There are environmental data showing that bacterial pathogens shed by both domestic and wild animals have been isolated from shellfish. However, there is little epidemiological evidence that illness outbreaks have been caused by shellfish harvested from waters polluted by animals. Unfortunately, epidemiological observations Waters containing domestic or wild animal wastes were considered to offer a reduced risk. However, the study group was not able to define the precise relationship between pollution from animal sources and human health risk.

Subsequently, a draft report on the workshop was submitted to the Institute Shellfish Sanitation Conference for deliberation at its fourth annual meeting in August 1986. At this meeting, the Conference requested that the Environmental Protection Agency conduct a literature search concerning animal pathogens which may be transmitted from animals through a shellfish vector to humans. This literature search was written to provide a summary of the current scientific significance of pollution associated with runoff to shellfish-harvest waters from animal sources such

Journal of Food Protection, Vol. 83, No. 1, 2020, Pages 6–12
https://doi.org/10.4315/0362-028X.JFP-19-318
Published 2020 by the International Association for Food Protection

Research Paper

Enumeration and Survival of *Salmonella enterica* in Live Oyster Shellstock Harvested from Canadian Waters

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MS 19-318: Received 9 July 2019/Accepted 5 September 2019/Published Online 4 December 2019

ABSTRACT

Since 2015, 11 recalls of live oyster shellstock have been issued in Canada due to the presence of *Salmonella enterica*. Six of those recalls took place in 2018. To understand this increase, fundamental information is needed on the relationship between *S. enterica* and oysters. The aims of this study were to address important data gaps concerning the levels of *Salmonella* in naturally contaminated oysters and the ability of this pathogen to survive in live oyster shellstock. Enumeration data were evaluated for five oyster and clam samples collected from the east coast of Canada from 2015 to 2018. The reported levels were <0.0015 to 0.064 most probable number per g of oyster tissue. The *S. enterica* isolates recovered from these animals belonged to serovars Typhimurium, Infantis, Enteritidis, and I 4,5:i:–. Filter feeding by the oysters was exploited to assess the *Salmonella* accumulation that would occur following a natural contamination event. Detectable levels of the pathogen were observed after 30 min of exposure and began to plateau at 60 min. A survival study in live oyster shellstock indicated that after 4 days of storage at ambient temperatures, the *Salmonella* level declined slightly from 4.3 to 3.7 log CFU/g. These data indicate that the levels of *Salmonella* found in naturally contaminated oysters are low and are not expected to increase between the point of harvest and the point of consumption. The changing ecology of shellfish environments requires continued monitoring and testing to safeguard public health. The data presented here will be useful for the evaluation and design of sampling plans and risk management approaches for the control of *Salmonella* in live oyster shellstock.

Risk Analysis, Vol. 42, No. 2, 2022 DOI: 10.1111/risa.13755

Risk Assessment of Norovirus Illness from Consumption of Raw Oysters in the United States and in Canada

Régis Pouillot,[1] Mark Smith,[2] Jane M. Van Doren,[1,*] Angela Catford,[2] Jennifer Holtzman,[2] Kevin R. Calci,[3] Robyn Edwards,[4] Gregory Goblick,[3] Christopher Roberts,[5] Jeffrey Stobo,[5] John White,[6] Jacquelina Woods,[3] Angelo DePaola, Jr.,[3] Enrico Buenaventura,[2] and William Burkhardt, III[3]

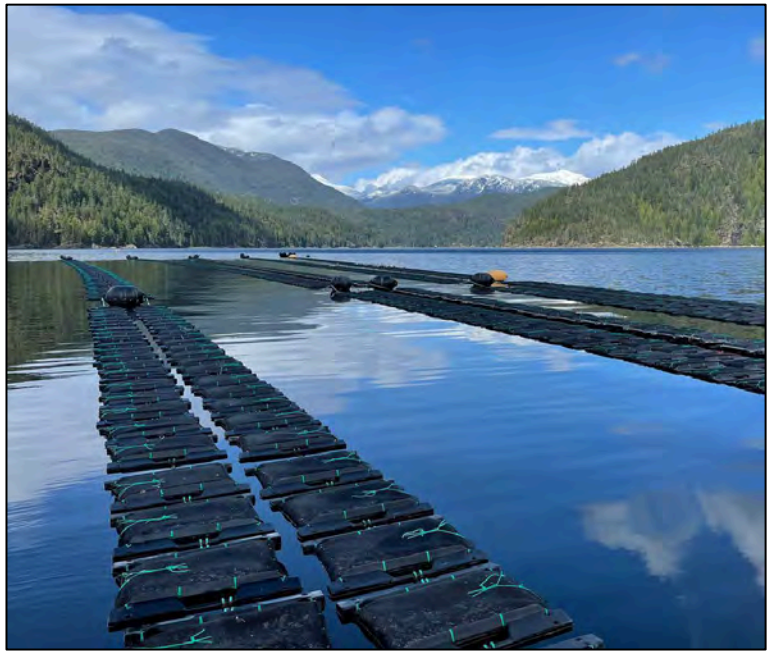
Table I. Considered Steps, Major Parameters, and Factors that May Impact the risk of NoV Illness Following the Ingestion of a Meal of Raw Oysters

Step	Major Parameter	Influencing Factor included in Modeling this Step
Wastewater treatment plant (WWTP) influent	Mean concentration of infectious and noninfectious NoV GI, NoV GII, and concentration of MSC in influent	MonthProportion of infectious NoV
WWTP treatment	Treatment efficiency	WWTP type (mechanical, lagoon, none) Disinfection process (chlorine, UV, none)Month
Harvest Water	Virus inactivation	Water temperature (function: region, day) Light energy (function: region, month) Time to reach the estuary (function: tide type)
	Dilution	Dilution at mean tide (function: estuary)Tide (function: region, hour)
Oysters at harvest	Bioaccumulation	Concentration of NoV GI, NoV GII, and MSC in the water Season (high bioaccumulation season: October–February; low bioaccumulation season: March–September) Water temperature (function: region, day)
	Elimination	Concentration of NoV GI, NoV GII, and MSC in the water Water temperature (function: region, day)
Consumption	Meal size	Number of oysters eaten

These are not equivalent…

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

Source: NE Shellfish Sanitation Assoc. Meeting April 9-10, 2019



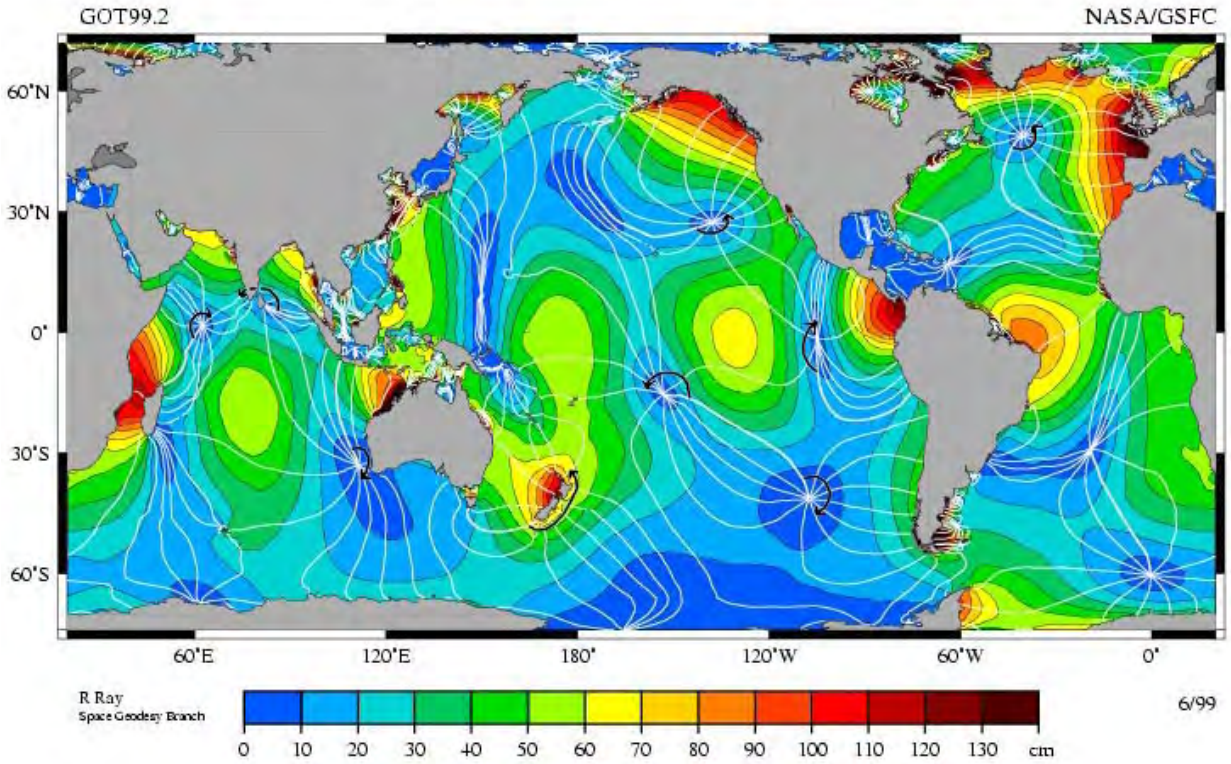
FANNY BAY OYSTERS®

Source: Social media image accessed at www.facebook.com/fannybayoysters/photos


Photo by P. Bloch

Photo by N. Taylor

Key Factor: Tidal Amplitude



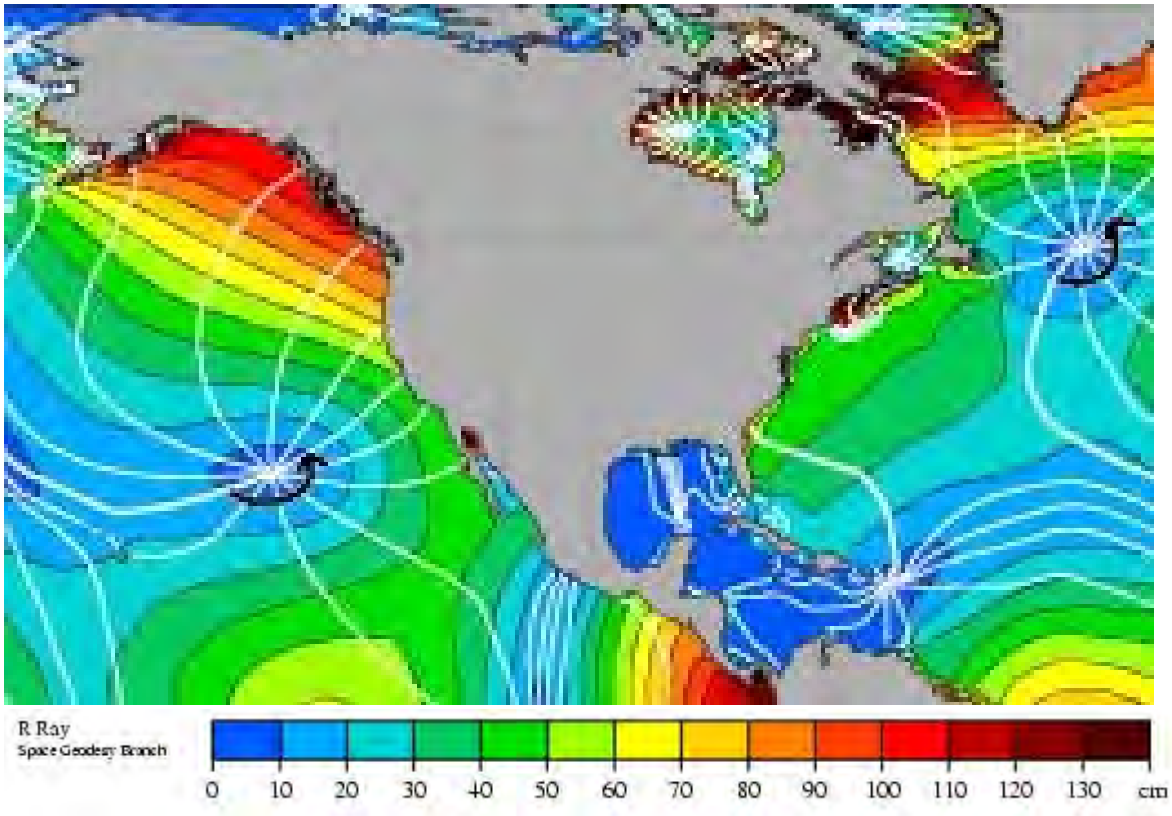
Amplitude = color (half the distance between high and low water)

White lines are cotidal by 30° (~1hr)

Curved arcs around amphidromic points show the direction of the tides (each a synchronized 6hr period)

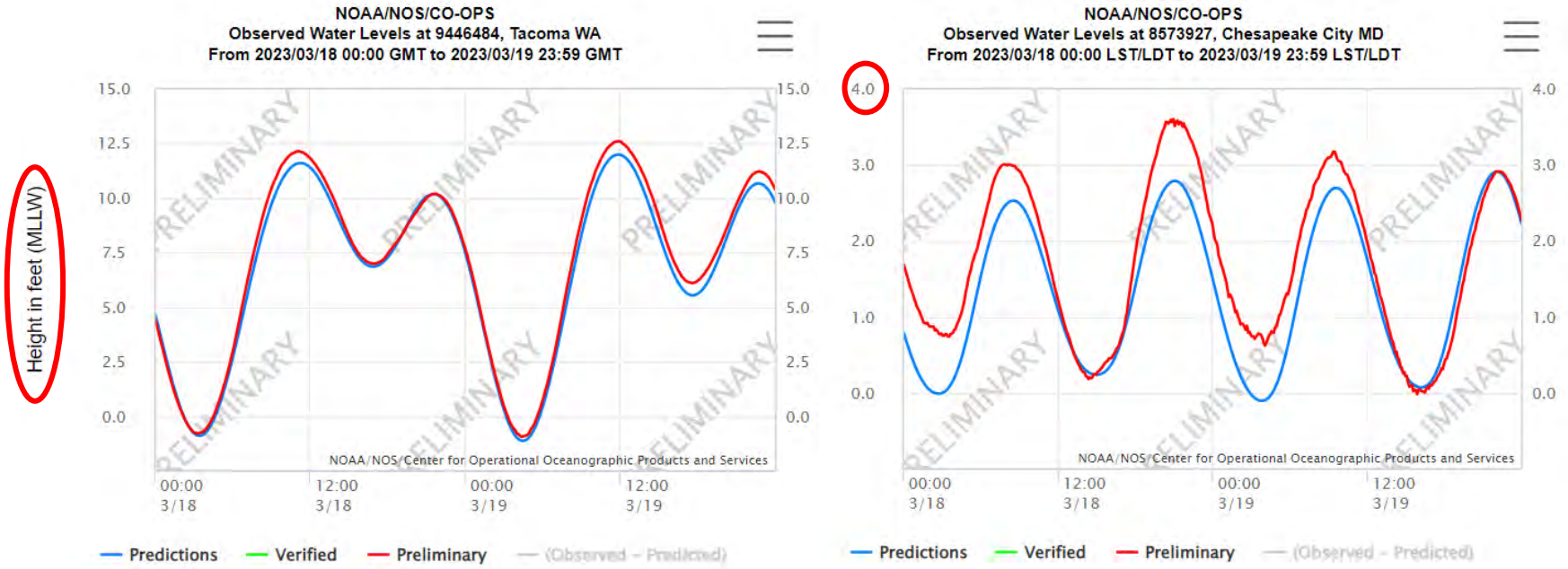
Source: https://upload.wikimedia.org/wikipedia/commons/5/5e/M2_tidal_constituent.jpg

North America Amplitude



Source: https://upload.wikimedia.org/wikipedia/commons/5/5e/M2_tidal_constituent.jpg

Tidal Height (MLLW)

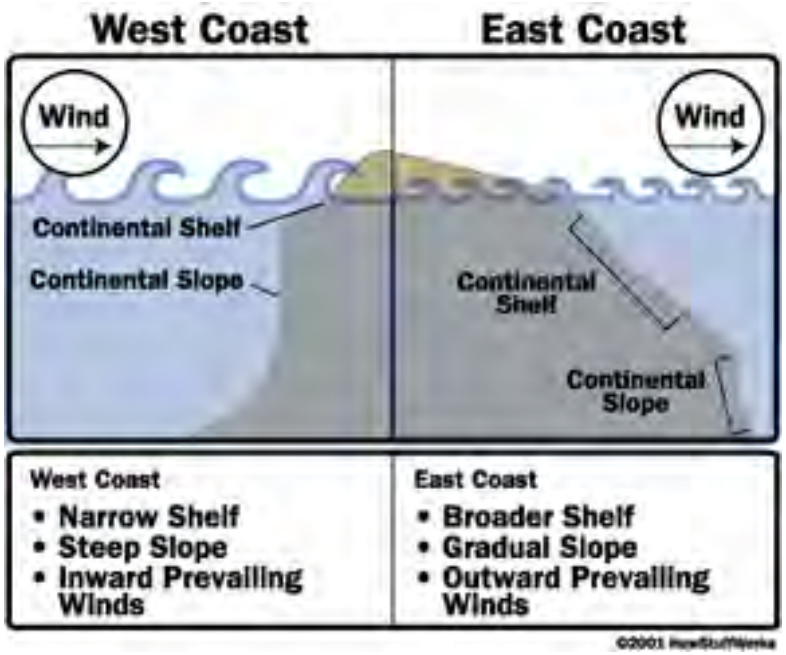


North America East & West

West Coast: prevailing winds are behind the waves, which increases the waves' energy.

East Coast: prevailing winds blow against the incoming waves, decreasing the waves' energy.

East Coast: the continental shelf is broader, e.g. there's more sand as the shelf drops gradually, like a long ramp.

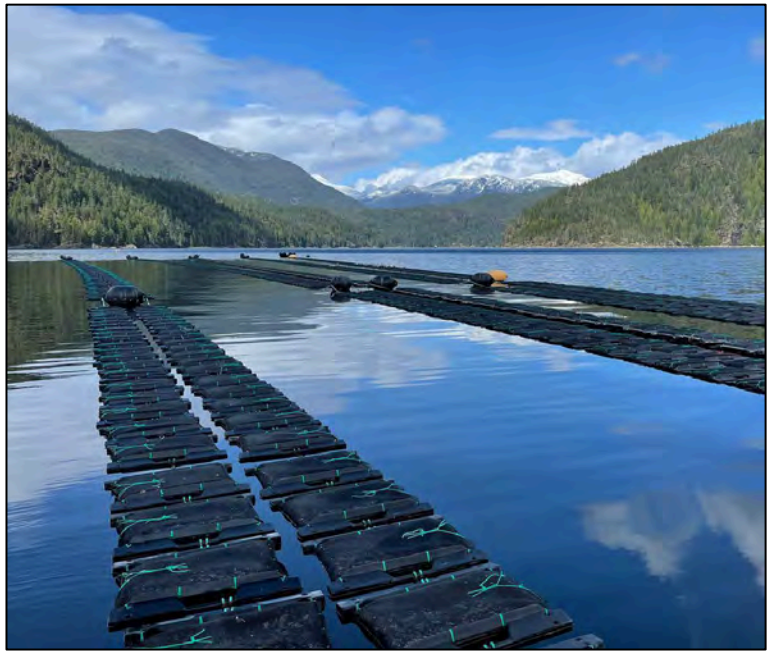


Source: https://science.howstuffworks.com/environmental/earth/oceanography/question623.htm

Again, not equivalent…

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

Source: NE Shellfish Sanitation Assoc. Meeting April 9-10, 2019



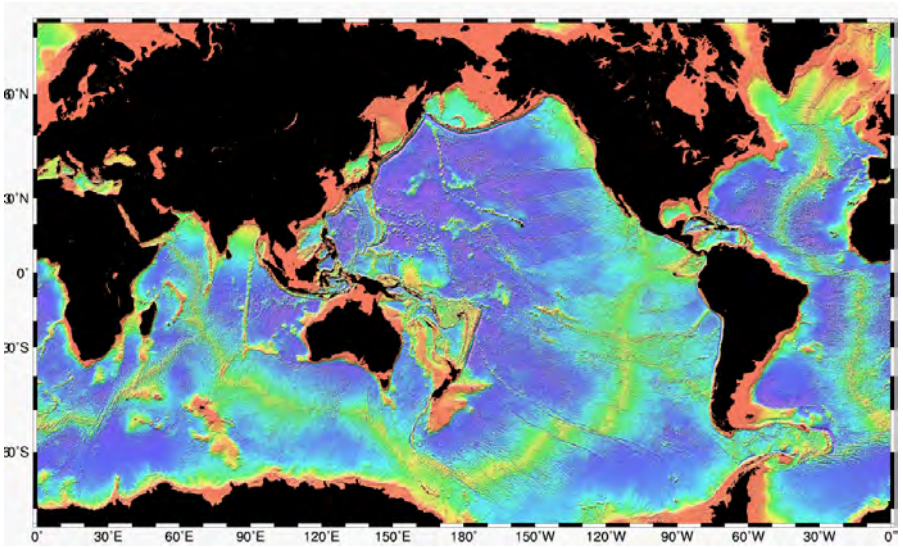
FANNY BAY OYSTERS®

Source: Social media image accessed at www.facebook.com/fannybayoysters/photos

Components of the Sanitary Survey (NSSP)

1. An evaluation of the pollution sources that may affect the growing areas.
2. An evaluation of meteorological factors.
3. An evaluation of hydrographic factors that may affect distribution of pollutants throughout the area.
4. An assessment of water quality.

Therefore, shouldn't regulatory requirements for managing birds also consider local conditions?



Source: NOAA, http://www.ngdc.noaa.gov/mgg/image/global_topo_large.gif

Why?

Attempt to control bird use on floating gear at all sites?

Add cost & ongoing additional maintenance for oyster farms?

Add disposable & aesthetically unappealing products to our coastal environments?

- **With little evidence of effectiveness of deterrents.**
- **No evidence of uniform need for deterrents to improve human health or illness risk.**

SEMAC Southeastern Massachusetts Aquaculture Center

Source: SMAC Presentation on Bird Deterrents https://x5qefe.p3cdn1.secureserver.net/wp-content/uploads/2022/06/Bird-deterrents-April-2022.pdf

The Market is Responding

OysterGro Aquafarming Systems by BBI Group
513 followers
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It seems that the challenge of bird mitigation is increasingly becoming a topic of concern and discussion.
With this in mind, we've been challenged by some leaders within our oyster farming community to see what our BBI team could come up with.
At OysterGro we do love a challenge so we put our thinking caps on and come up with this concept to start the conversation.
Good, bad or indifferent let us know your thoughts, as a comment on this post or on email at info@oystergro.com

Source: LinkedIn post by OysterGro Aquafarming Systems
https://www.linkedin.com/posts/oystergro_as-a-continuation-of-our-conversation-on-activity-7042173903061798912-PI6F?utm_source=share&utm_medium=member_desktop

Innovation is important, but..

Source: https://avectous.com/2020/03/20/the-horse-before-the-cart/

What about decontamination?

Canadian producers must now develop plans to “decontaminate” oysters from floating gear.

Where’s evidence that oysters are contaminated, esp. all the time?

How can a farm develop decontamination protocols without:

1. A starting point / level of contamination?
2. A risk assessment to inform desired level of reduction?

Government of Canada

Regulations Respecting the Management of Contaminated Fisheries

Short Title

1 These Regulations may be cited as the *Management of Contaminated Fisheries Regulations*.

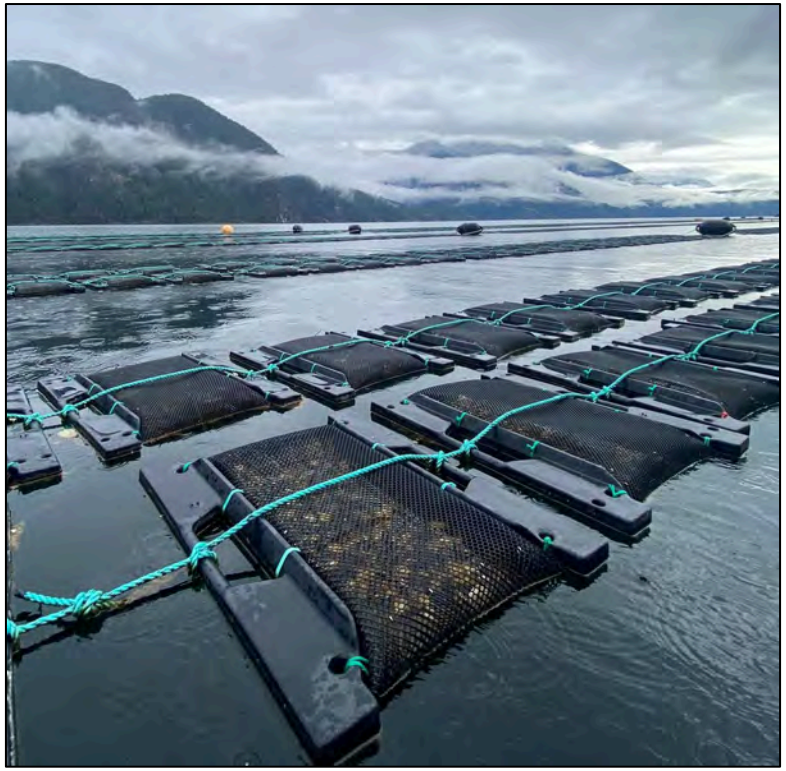
Interpretation

2 In these Regulations,

contaminated, with respect to fish, means fish in or on which bacteria, toxins, chemical compounds or other substances are present to a degree that may constitute a danger to public health; (*contaminé*)

Conclusions

1. Birds have the potential to negatively impact water quality, but the potential disease risk to humans remains unknown.
2. Factors contributing to proliferation of FC varies widely.
3. Aquatic environments cannot be assumed to be equivalent.
4. In the absence of an established risk threshold, shellfish farms should not be expected to manage risk.



Source: Social media image accessed at www.facebook.com/fannybayoysters/photos

Questions?

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