# National Shellfish Sanitation Program Five Marine Biotoxin Strategies, Challenges for Offshore Bivalve Molluscan Shellfish Harvest

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*World Seafood Congress in Association with the*
*13th International Conference on Molluscan Seafood Safety*

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*International Affairs, Trade, and Commerce | Seafood Inspection Program*
*NOAA Fisheries | U.S. Department of Commerce*

# National Shellfish Sanitation Program (NSSP)

## Guide for the Control of Molluscan Shellfish 2019 Revision

From the U.S. Food and Drug Administration website
http://www.fda.gov/Food/GuidanceRegulation/FederalStateFoodPrograms/ucm2006754.htm



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# NSSP

- Cooperative program between federal government, participating states, and tribes where states are the primary authority.

- Definition of shellfish:

  "means all species of:

  Oysters, clams, mussels, or cockles whether:

  Shucked or in the shell;

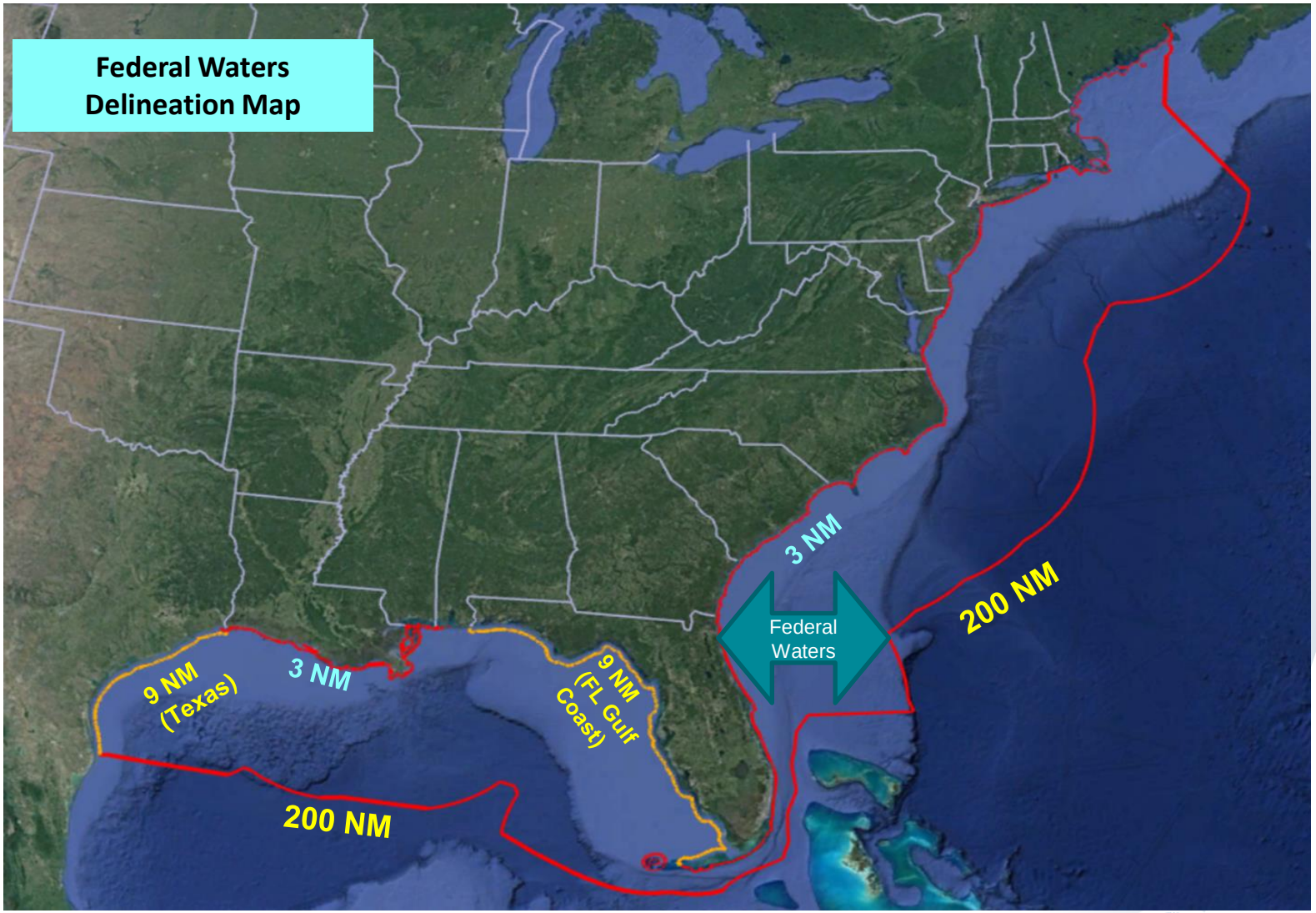
  Raw, including post-harvest processed;

  Frozen or unfrozen

  Whole or in part; and

  Scallops in any form, except when the final product form is the adductor muscle only."

# NSSP in Federal Waters



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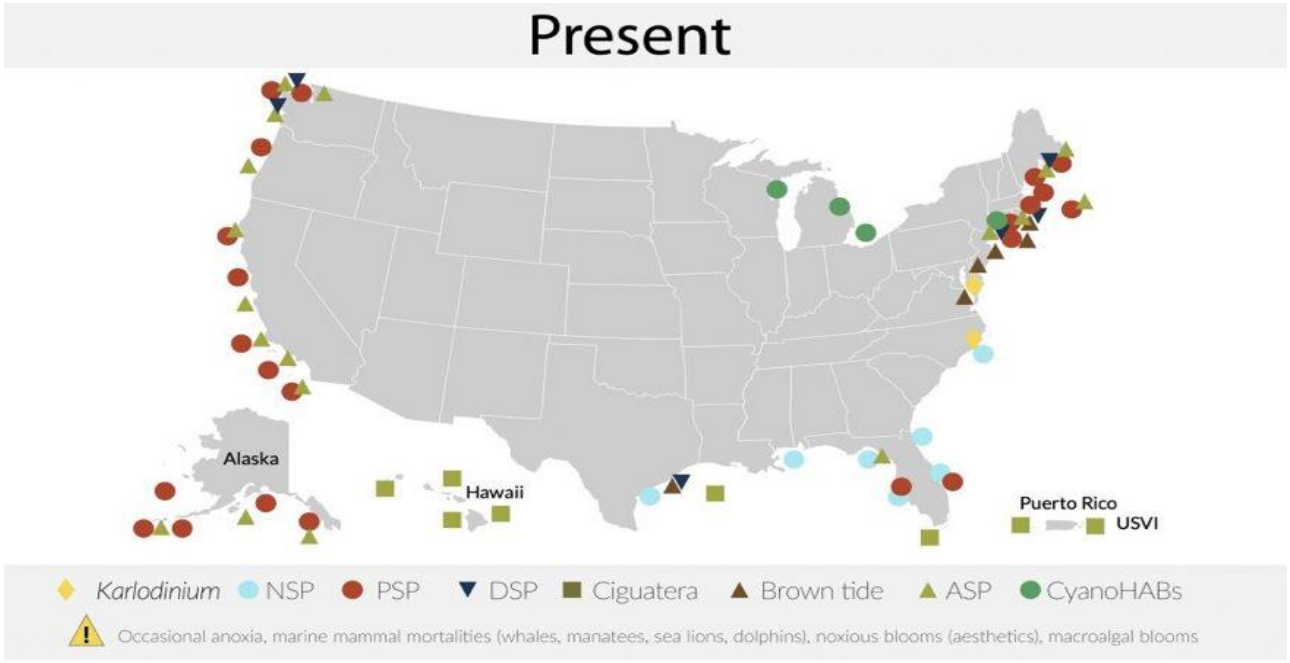
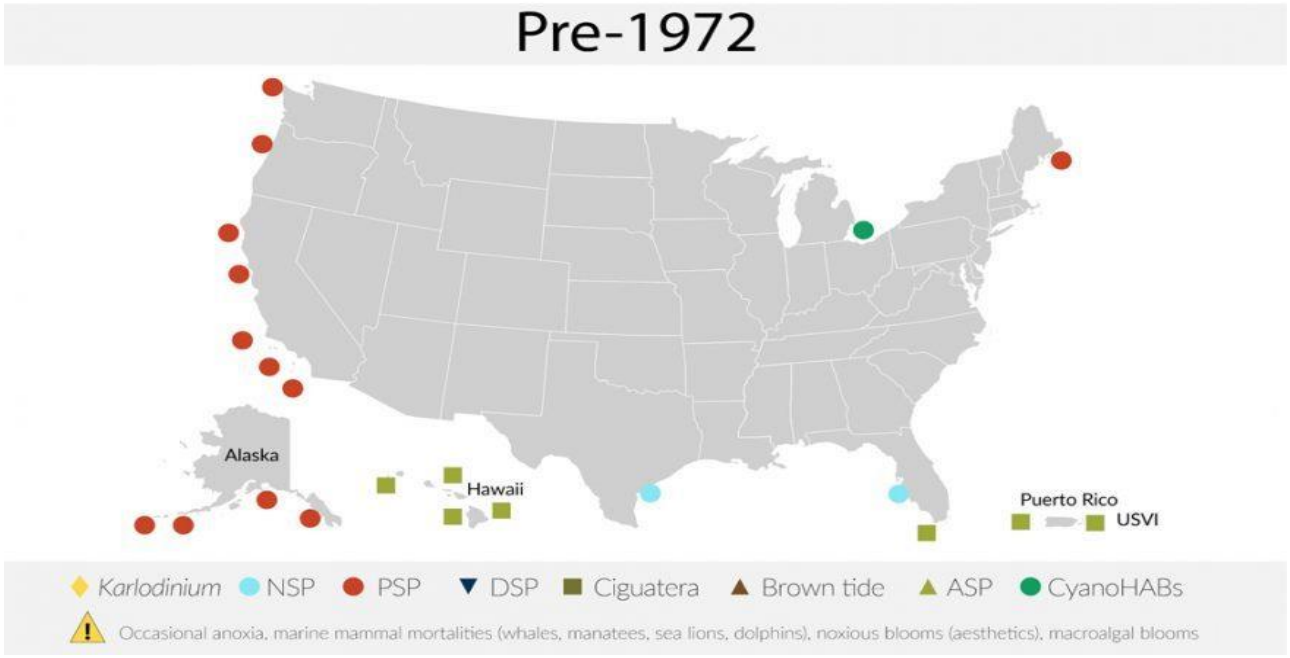
# US HABs Pre-1972 vs 2019




Credit: U.S. National Office for Harmful Algal Blooms

# NSSP Model Ordinance
## Five Types of Shellfish Poisonings

- **PSP** - Paralytic Shellfish Poisoning
- **NSP** - Neurotoxic Shellfish Poisoning
- **ASP** - Amnesic Shellfish Poisoning (also known as Domoic Acid poisoning)
- **DSP** - Diarrhetic Shellfish Poisoning
- **AZP** - Azaspiracid Shellfish Poisoning



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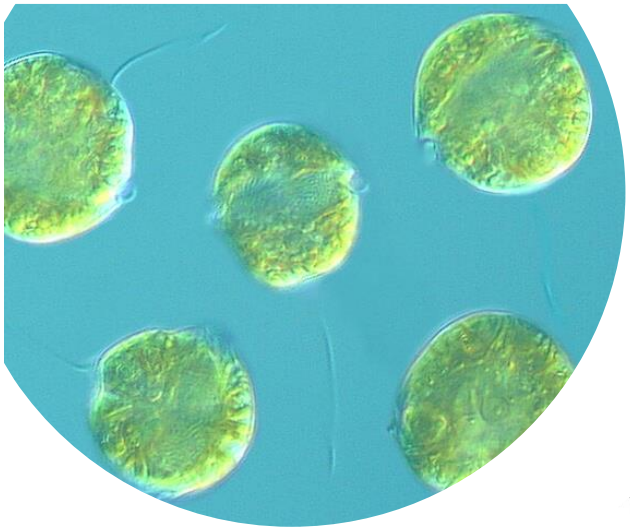
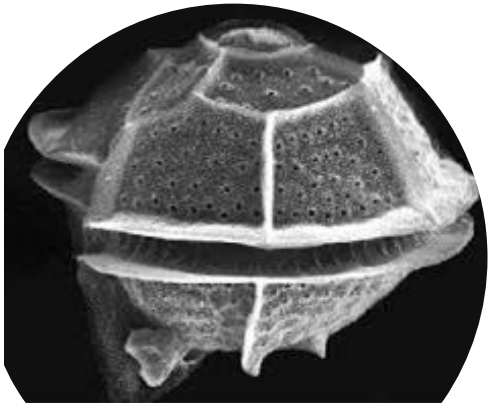
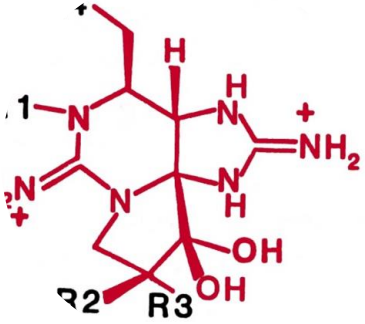
# Paralytic Shellfish Poisoning (PSP) Toxins








Saxitoxins (STXs)

Dinoflagellates

*Alexandrium* spp.
*Gymnodinium catenatum*
*Pyrodinium bahamense*

Guidance Level

80 µg/100 g

Credit: Stacey Wiggins, PhD, US FDA CFSAN



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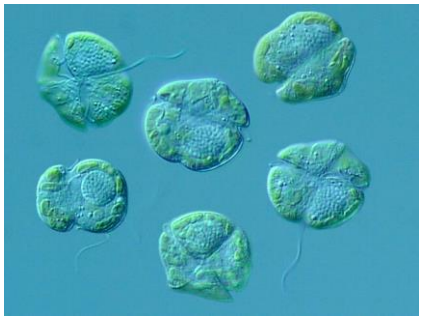
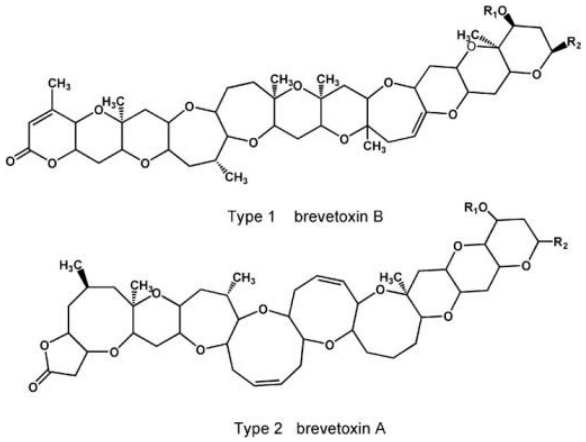
# Neurotoxic Shellfish Poisoning (NSP) Toxins



Brevetoxins (BTXs)

Dinoflagellate

*Karenia brevis*



Type 1 brevetoxin B

Type 2 brevetoxin A

Guidance Level

20 MU/100 g

Credit: Stacey Wiggins, PhD, US FDA CFSAN



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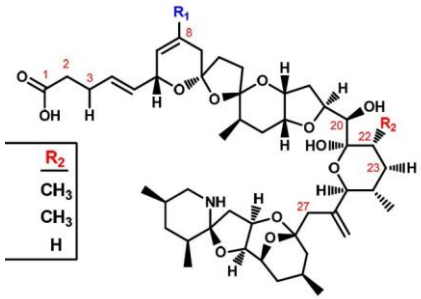
# Azaspiracid Shellfish Poisoning (AZP) toxins

Azaspiracids (AZAs)

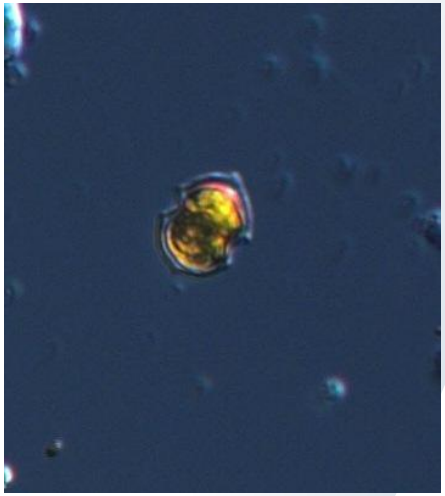
Dinoflagellates

*Azadinium* spp.




Guidance Level

0.16 mg/kg



Credit: Stacey Wiggins, PhD, US FDA CFSAN



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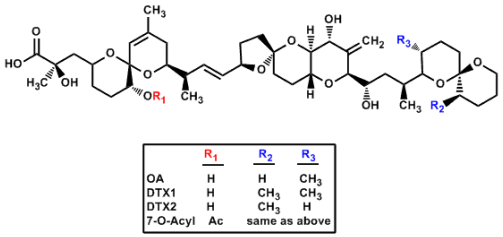
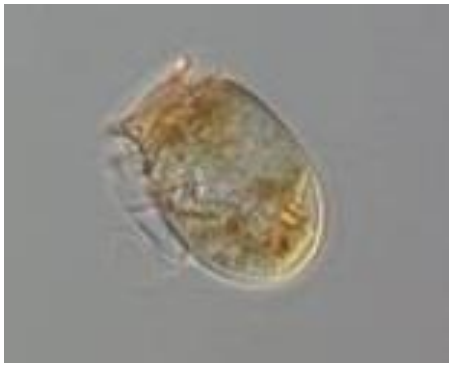
# Diarrhetic Shellfish Poisoning (DSP) Toxins



| | $R_1$ | $R_2$ | $R_3$ |
|---|---|---|---|
| OA | H | H | $CH_3$ |
| DTX1 | H | $CH_3$ | $CH_3$ |
| DTX2 | H | $CH_3$ | H |
| 7-O-Acyl | Ac | same as above | |



Okadaic Acid & Dinophysis Toxins (OA & DTXs)

Dinoflagellates

*Dinophysis* spp.

*Prorocentrum* spp.

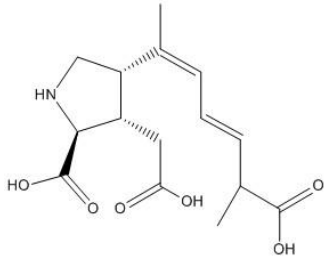
Guidance Level

0.16 mg/kg

Credit: Stacey Wiggins, PhD, US FDA CFSAN

# Amnesic Shellfish Poisoning (ASP) Toxins

Domoic Acid (DA)

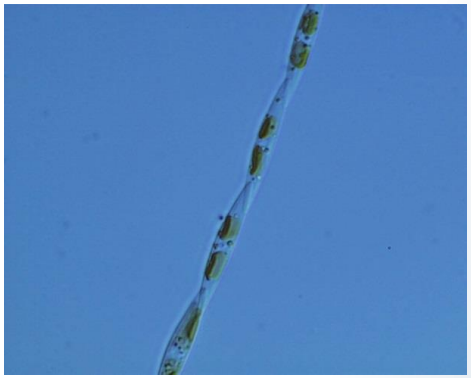



Diatoms

*Pseudo-nitzschia* spp.

Guidance Level

20 mg/kg



Credit: Stacey Wiggins, PhD, US FDA CFSAN



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# Controlling Marine Biotoxin in Shellfish

## Contingency Plan

- Emergence of toxin-producing phytoplankton that has historically occurred
- New illness outbreak
- Reactive management

## Management Plan

- History of biotoxin closures
- Toxin-producing phytoplankton
- Reasonable likelihood that biotoxin closures could occur



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# Section II. Model Ordinance
# Chapter IV. Shellstock Growing Areas
# B. Marine Biotoxin Management Plan and @.04 Marine Biotoxin control

- Management Plan
- **5 Management Strategies - Options**
- Model Ordinance guidance/strategy
- New “Controlled Access Status”



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# Federal Waters Molluscan Shellfish Harvest
## *Marine Biotoxin*

*<u>Management Strategies:</u>*

1. Phytoplankton monitoring
2. Routine shellfish toxicity monitoring
3. Pre-harvest shellfish toxicity testing
4. Shellfish lot testing
5. Pre-harvest shellfish toxicity screening and lot testing

# *Phytoplankton Monitoring*

- Routine monitoring
- Frequency based on historic database
  - Or, 36 samples over 3 years – from representative environmental conditions
- Must be used with another strategy
  - Trigger shellfish toxicity testing
- Potential scenarios
  - Traditional monitoring programs used by states
  - Aquaculture sites in nearby federal waters

Credit: Stacey Wiggins, PhD, US FDA CFSAN



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# *Shellfish Toxicity Monitoring*

- Routine Sampling
- Frequency based on historic database
  - Or, 36 samples over 3 years – from representative environmental conditions
- Species-Specific
  - Or use highest risk species
- Potential scenarios
  - Traditional monitoring programs used by states
  - Aquaculture sites in nearby federal waters


Credit: Stacey Wiggins, PhD, US FDA CFSAN



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# *Pre-Harvest Shellfish Toxicity Testing*

- Testing – Pre-harvest
- Harvest Area – Specific to intended harvest area
- Advance – Short duration (3 days)
- Potential scenarios
  - Easily accessible and remote
  - Wild harvest and aquaculture
- Frequency: 36 samples/3 years

*Credit: Stacey Wiggins, PhD, US FDA CFSAN*

*Photo credit: NOAA Fisheries - Julie Rose*



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# *Shellfish Lot Testing*

- Testing – post-harvest
- Lot – specific to harvest area/lot
- Controlled – controlled access status
- Tags – restricted shellstock tags/require holding shellstock until lots tests are available
- Potential scenarios
  - Easily accessible and remote
  - Wild harvest and aquaculture
- Frequency: 36 samples/3 years


Credit: Stacey Wiggins, PhD, US FDA CFSAN



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# *Pre-Harvest Screening + Lot Testing*

- Pre-harvest  Shellfish Screening/intended harvest area coupled with:
- Lot – Testing Upon Landing/initial Dealer
- Controlled – Controlled Access Status
- Tags – Restricted Shellstock tags/require holding shellstock until lots tests are available
- Potential scenarios
  - Easily accessible and remote
  - Wild harvest and aquaculture
- Frequency: 36 samples/3 years

Credit: Stacey Wiggins, PhD, US FDA CFSAN



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# Challenges and the Future

Emerging technology models

- Machine learning forecasting with toxin data
- Biological/Physical model using oceanographic, weather, and ship-based survey of cysts
- Drone sampling, Imaging FlowCytobot, Environmental Sample Processor - imaging real-time, Other?

# Thank You!

# Questions?

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