Marine Reservoirs for ISAV:

Do they play a role in Maine?

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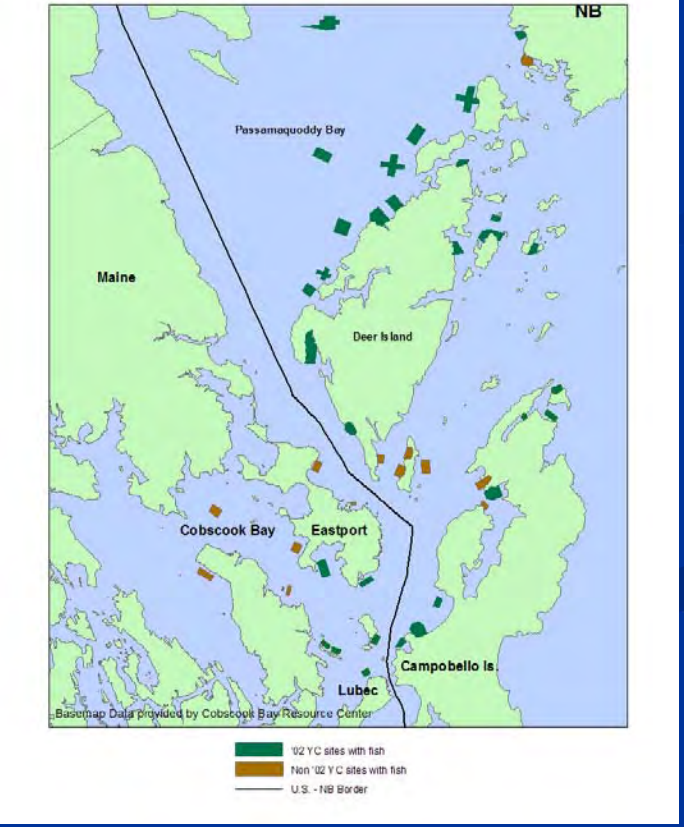


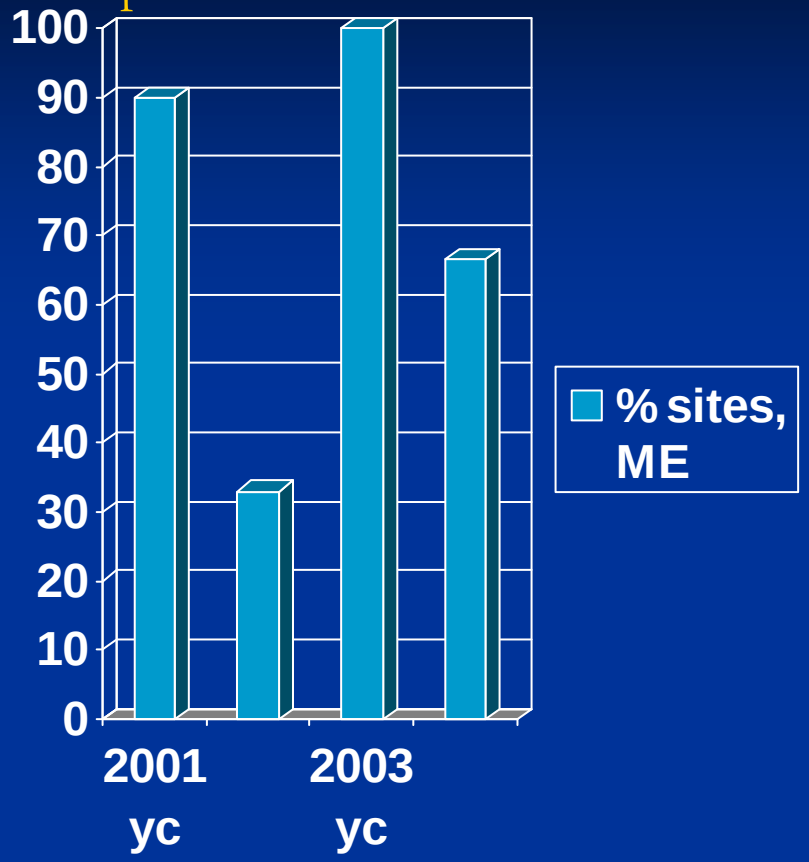
Infectious Salmon Anemia (ISA)

- USDA ISA Program began Jan. ’02
- Bay-wide depopulation
- Complete C & D
- 105 day fallow
- Restocking under arbitrary geographic bay management plan
- Lower stocking density per cage
- Strict biosecurity
- Mandatory surveillance
- Mandatory IPM for sea lice

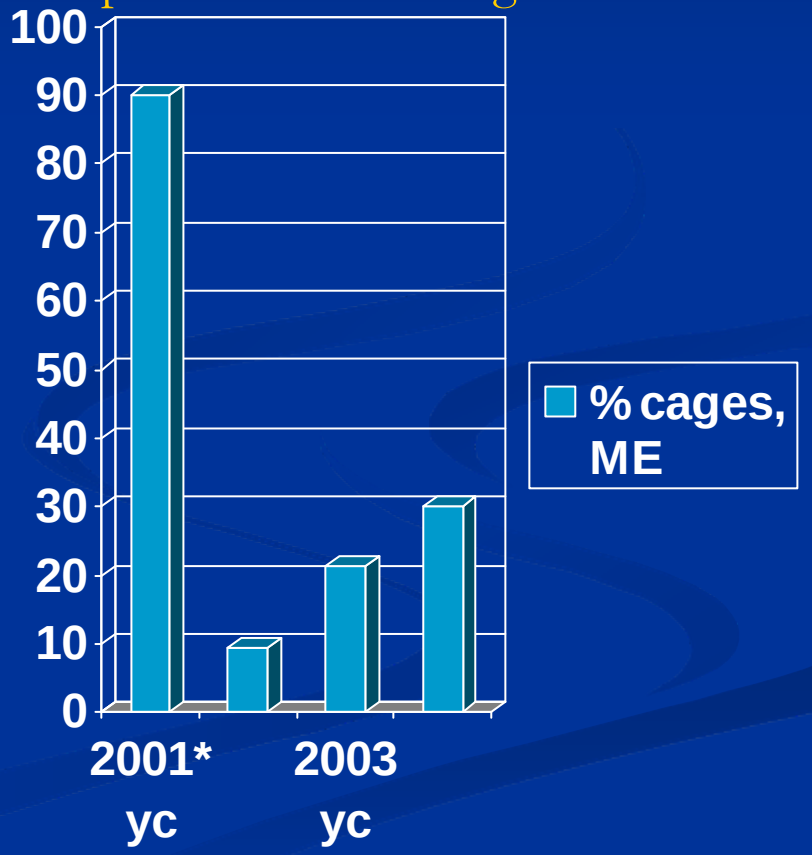
And it worked …

… in part

US Quoddy region:
percent infected sites



US Quoddy region:
percent infected cages



What's going on?

An initial study found ISAV material throughout the environment

- Microtechnologies, Inc., NBDAFA and APHIS VS
- Visited an infected site in NB
- 9 visits in 6 months
- Sampled fish, cages, vessel hulls and work surfaces, invertebrates, shellfish, water

Results concerning

	# RT-PCR positive
Boat hulls	5/15
Sediments, mussels	0/38
Sea Lice-Leps	**43/44**
Cage pontoons	24/45
Seawater, in cages	**23/45**
Salmon	207/285
Seawater ≤ 1.5 km up & downstream	**30/85**

Equal occurrence among fish and parasites at a pathogenic ISAV site

ISAV North American genotype

Lepeophtheirus salmonis

	Sea Lice PCR+	Sea Lice PCR-	Totals
Fish PCR+	40	1	41
Fish PCR-	3	0	3
Totals	43	1	44

More common occurrence in parasites than fish at a non-pathogenic ISAV site

ISAV european genotype

Caligus sp.

	Sea Lice PCR+	Sea Lice PCR-	Totals
Fish PCR+	4	0	4
Fish PCR-	25	76	101
Totals	29	76	105

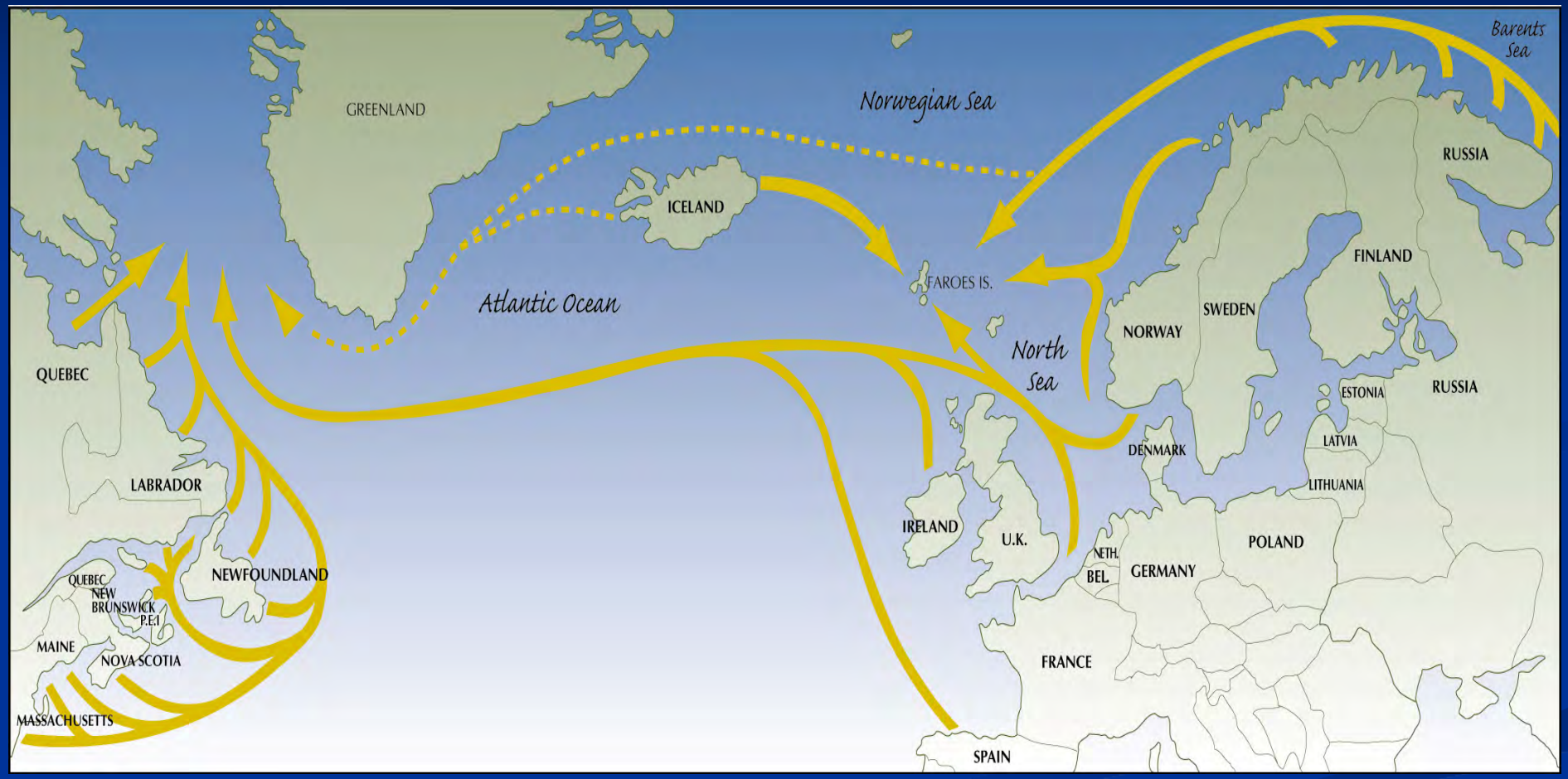
But sea lice are not a clear driving force for ISAV in Maine

- SLICE INAD and Mandatory Sea Lice Management
- Data available, by bay, for retrospective review
  - Initial date of lice settlement
  - Initial date of ISAV detection
- Pathogenic ISAV detected BEFORE leps in 4/6 cases; nonpathogenic detected BEFORE caligus in 6/9 cases of co-occurrence

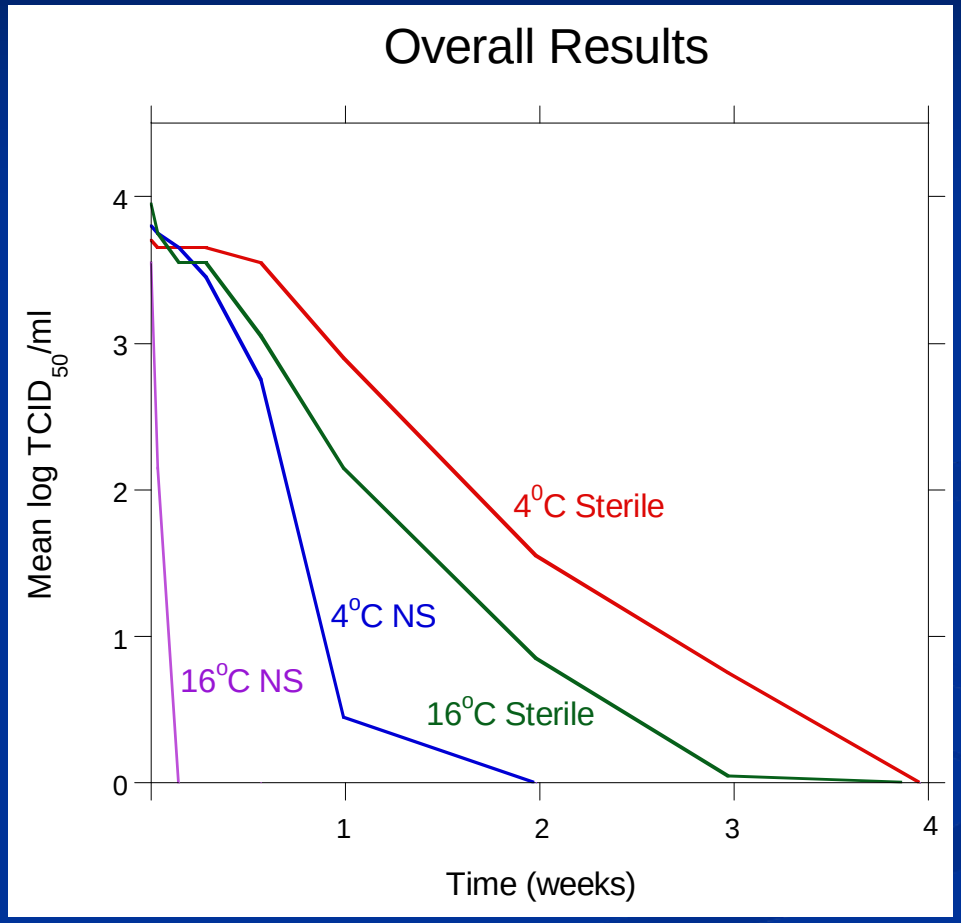
Wild Fish Positives: few but far between

- NMFS Wild Fish Survey, S MacLean
  - Sampled 3000 fish of 20 species, 2001-2007
  - Found few ISAV positives
    - 1 alewife (of 900), Narraguagus River (NA)
    - 1 ATS (of 500), W. Greenland fishery (NA)
- USFWS, T. Barbash
  - USFWS periodically tests ATS returns
  - Found a single positive, but not confirmed in repeat testing of the same fish
    - 1 ATS, Penobscot River (EU)

Wild Atlantic Salmon

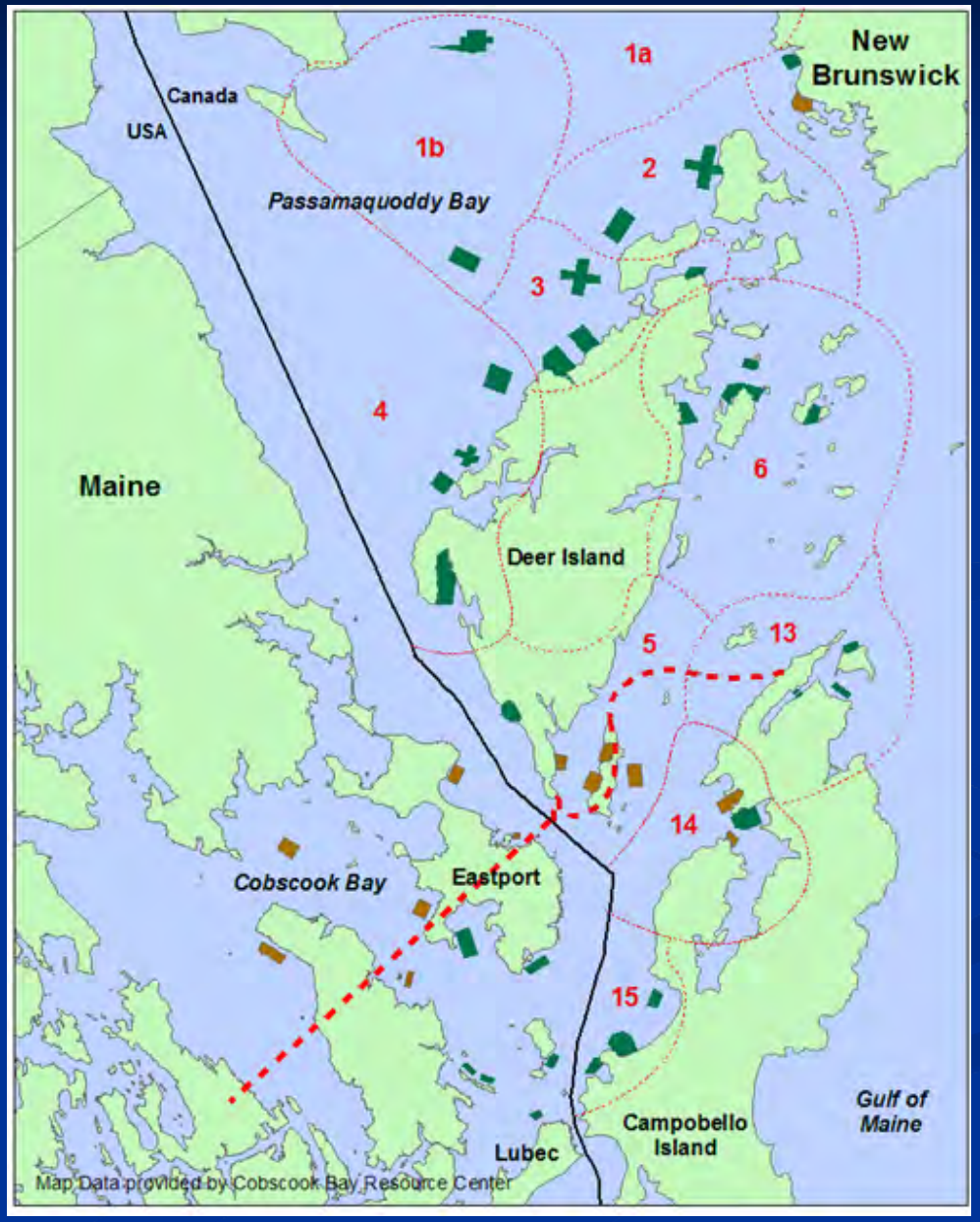


ISAV Longevity $TCID_{50}$ Trials cultured virus from non-sterile seawater

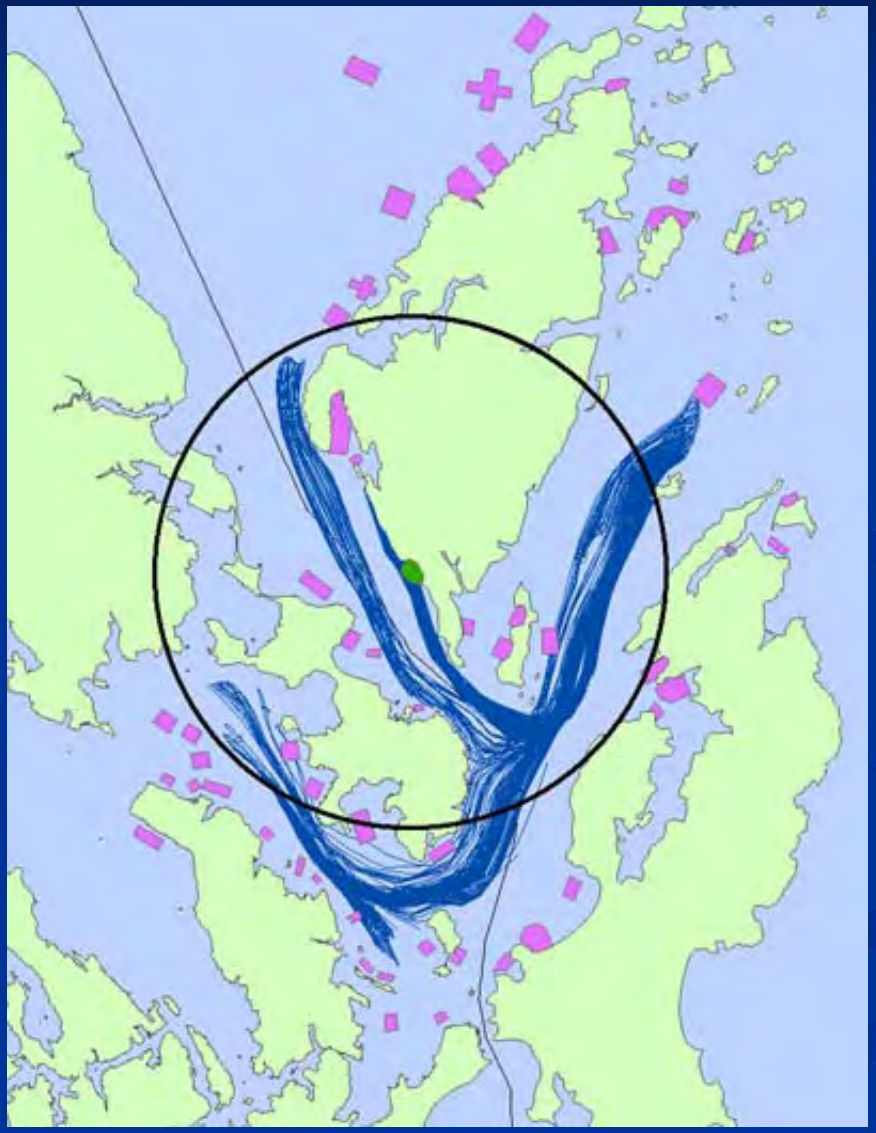


From: Giray et al (Micro Technologies, Inc., Richmond, ME)
"Environmental persistence of Infectious Salmon Anemia virus"

Too many Bay Management Areas?



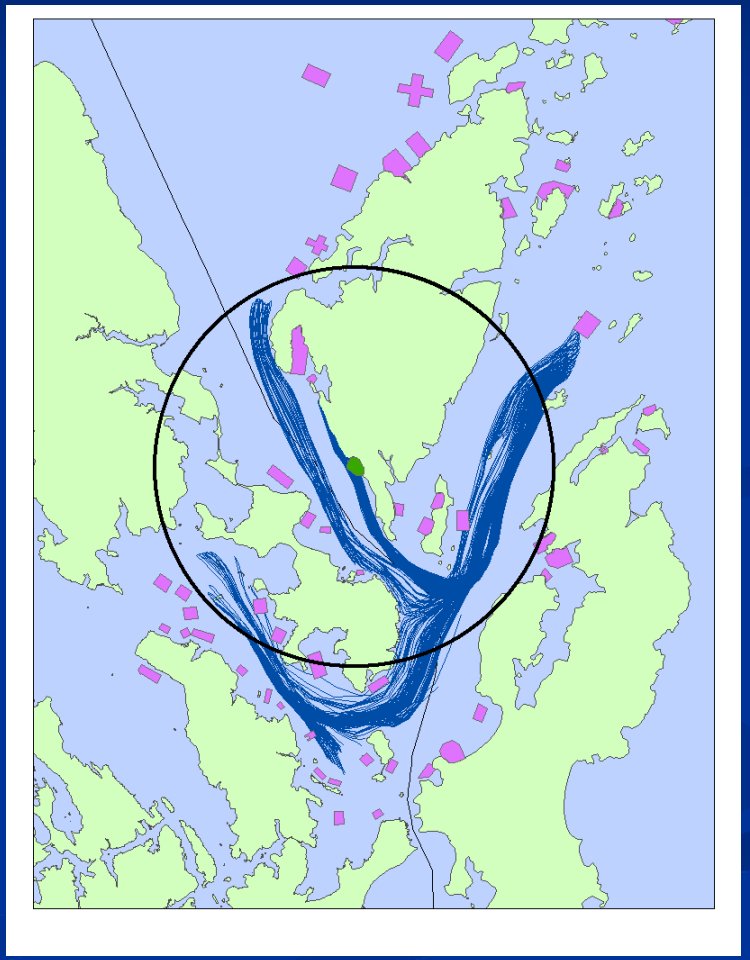
Tides are strong in this region



But changes in zoning are not easy

Do ISAV outbreak patterns suggest a tidal influence?

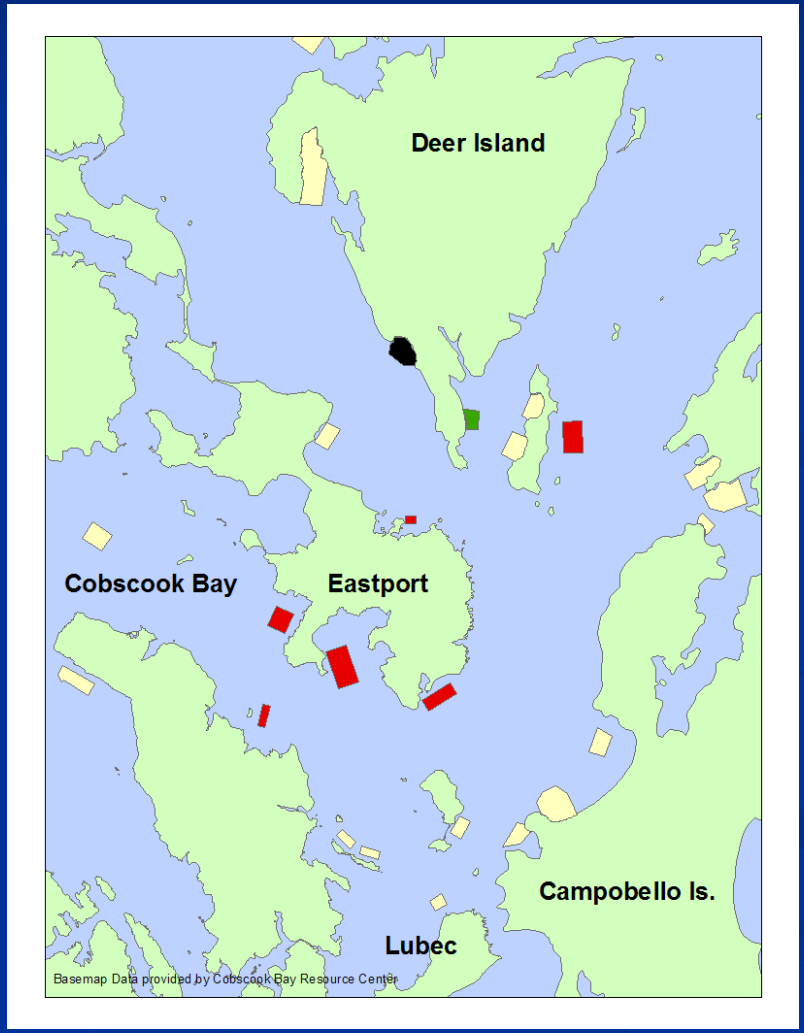
- ISAV data from
  - 32 sites with 2002 year class (spring entry) fish
  - 28 months of data (first stocking to latest removal)
- Hydrographic linkage tracks
  - A single tidal excursion
    - Modeled by DFO
    - Based on M2 tide
    - Substantiated by current meter and drifter studies
  - Rather than linear distance



Base Map Data provided by Cobscook Bay Resource Center

Gustafson et al., 2007, Preventive Veterinary Medicine 78, 35-56.

A single tidal excursion links this example site to 7 other sites



Time-series cross-sectional analysis

The number of New Outbreak Cages is predicted by

Variable	Estimate	P value
On-site outbreaks, 1 month ago	0.147	< 0.001
On-site outbreaks, 3 months ago	0.131	< 0.001
Wharf outbreaks	0.032	0.007
Susceptible cages	0.004	0.023
Holdover (yes/no)	0.096	0.038
Upstream late removals	0.141	0.015
Upstream outbrks	**0.198**	< 0.001

$R^2 = 0.187$

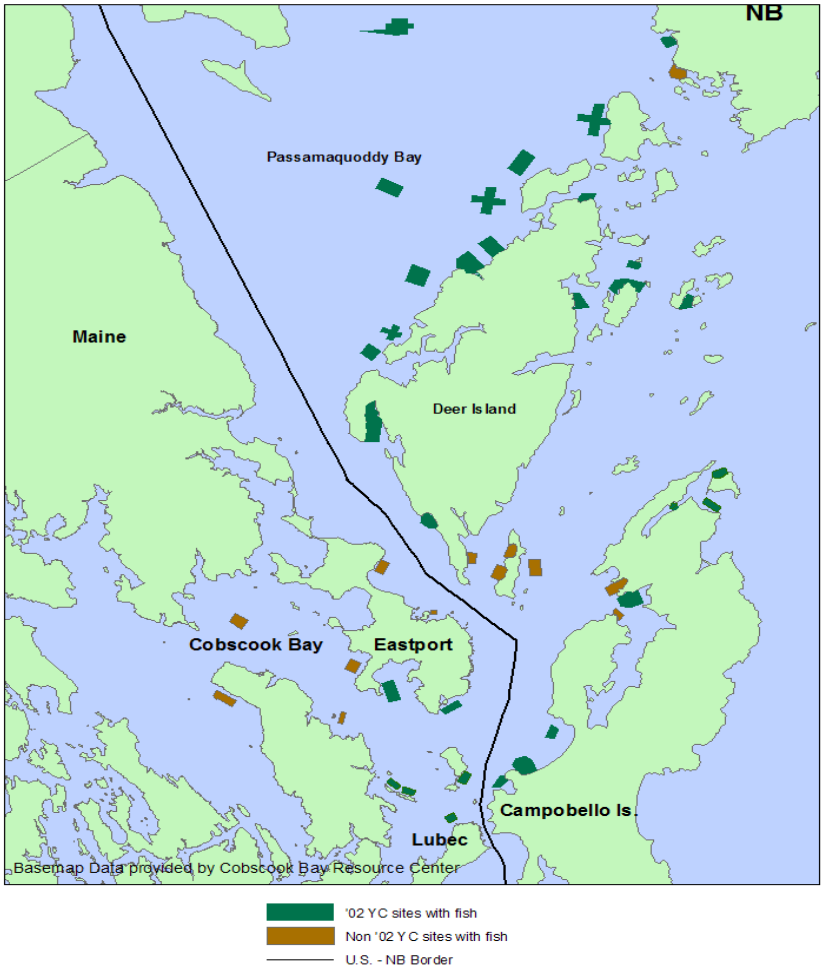
Biological significance of upstream events

- When analyzed by week
  - Upstream outbreaks 2-3 wks prior were most predictive.
  - ISAV incubation is similar.
- The pattern suggests waterborne transmission

Predictive strength is limited

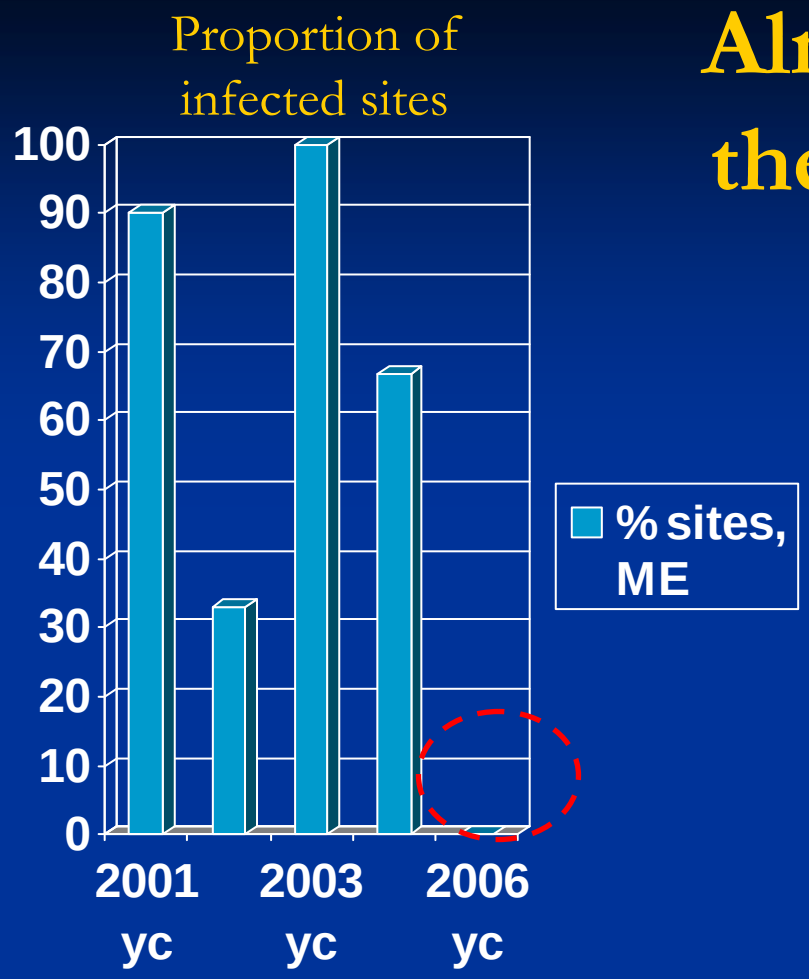
- The model 'explains' 19% of variation in outbreaks
  - 11% attributed to upstream events.
- But, a large R^2 is unlikely.
  - Field data are often imprecise.
  - Wind- or freshwater-driven mixing is not addressed.
  - Model doesn't address biosecurity, husbandry, hatchery, strain variation or other factors of possible influence.

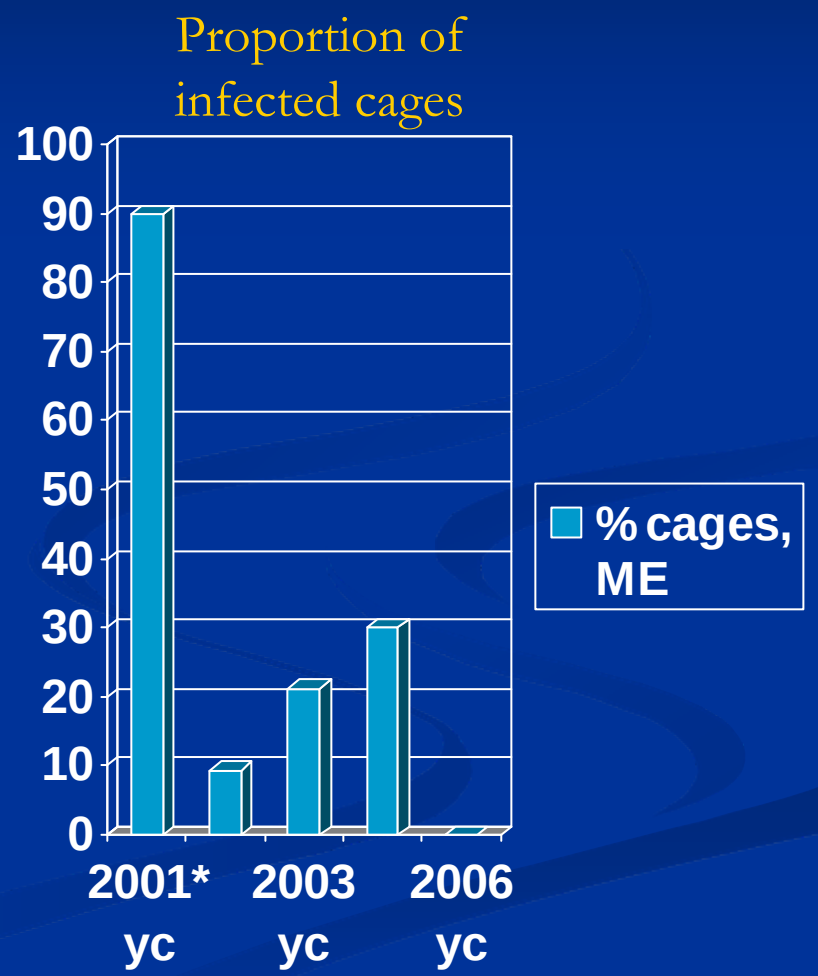
Starting 2006, all one zone



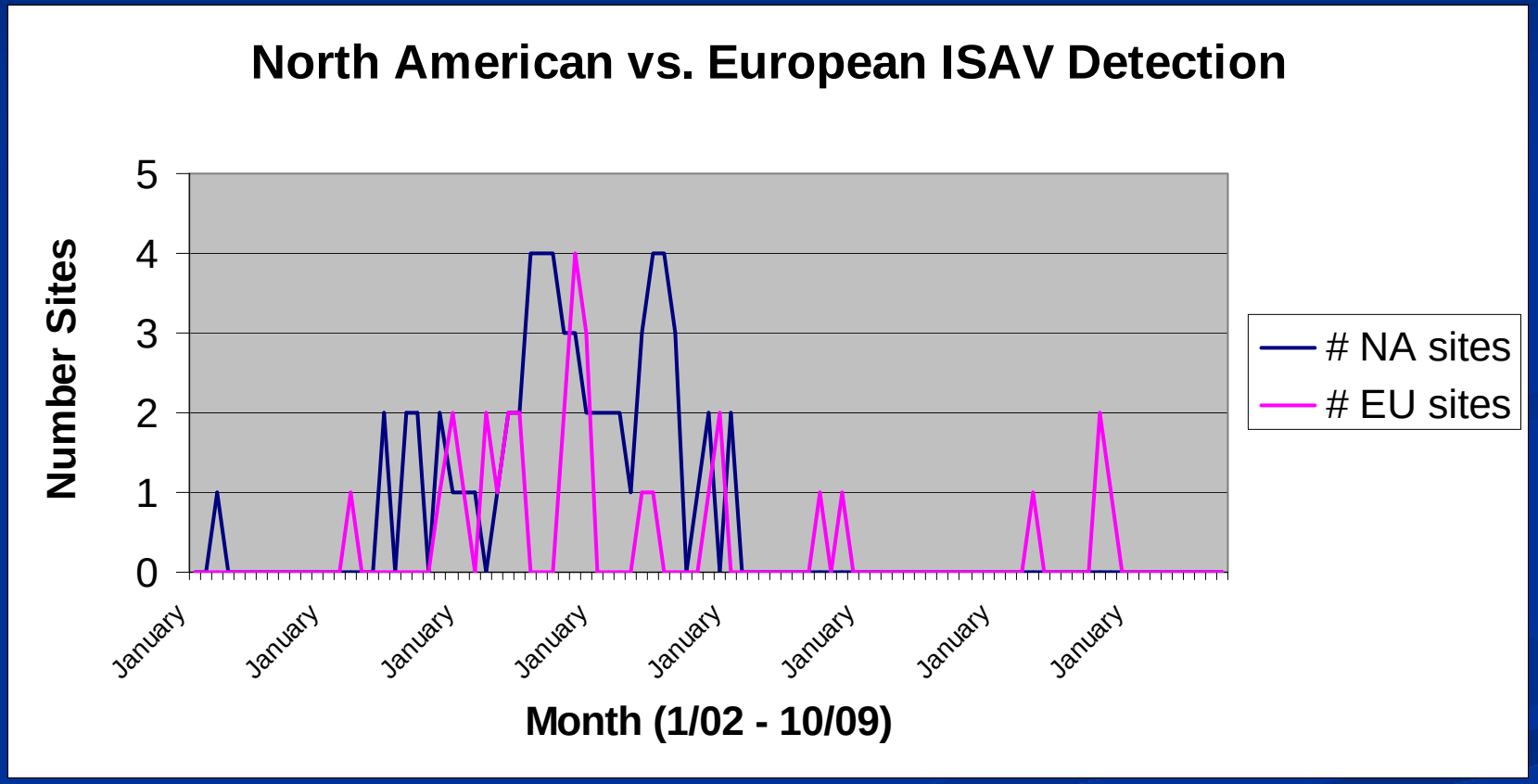
Base Map Data provided by Cobscook Bay Resource Center

Almost 4 years since the last clinical case





But, the non-pathogenic genotype persists



These appear to be reservoirs that we can live with

- The concern
  - 1) Do marine reservoirs for ISAV virus exist, and
  - 2) Do they explain the outbreak patterns in farmed salmon?
- The conclusion
  - (1) Yes, ISAV is found in wild fish, and in sea lice.
    - Wild fish (movements or processing) or parasites may explain initial ISAV NA introductions and/or ongoing ISAV EU occurrence
  - (2) No, they don't really explain outbreak patterns.
    - Patterns and control are better explained by waterborne and fomite spread among infected farms.

Thank you for your attention

USDA

VS Veterinary Services

Questions? lori.l.gustafson@aphis.usda.gov