

Endocrine disruptors in Jamaica Bay

Presentation to Jamaica Bay Watershed Protection Plan Advisory Committee - May 15, 2006

Anne McElroy

Marine Sciences Research Center

Stony Brook University



Acknowledgements

- ✓ Collaborators at MRSC: Bruce Brownawell, Adria Elskus Lee Ferguson, Charles Iden, Lourdes Mena, Meg McArdle, Sharanya Reddy, & Julia Todorov
- ✓ Collaborators at AREAC: Martin Schreiberman & Lucia Cepriano
- ✓ Gateway National Recreation Area, National Park Service
- ✓ New York State Department of Environmental Conservation (NYSDEC)
- ✓ Funding from the National Oceanic and Atmospheric Administration through New York Sea Grant and the Hudson River Foundation

Endocrine Disruption

•Alteration in hormone levels or function.

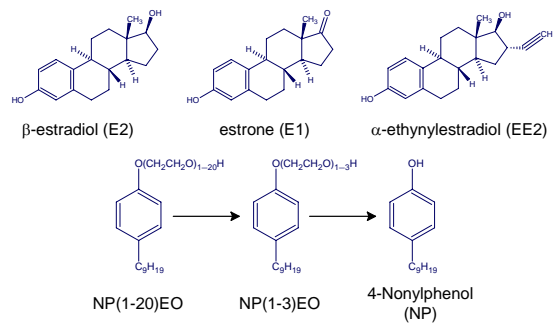
Hormones

•Chemical messengers that act at a distance. Very potent, feed-back systems.

•Regulate salt, sugar, and water balance, heart beat, growth, immune response, digestion, neurological status interactively.

•Because the reproductive hormones are also involved in differentiation and development, signals at inappropriate times can really mess things up.

Potent EDCs in Sewage Effluent



Fate and Effects of endocrine disrupting agents in NY/NJ Harbor Estuary

- ✓ Estrogenicity of effluent from NYC STPs – Yonkers, Rikers Island, Red Hook and 26th Ward
- ✓ Geochemistry of NPEOs in Jamaica Bay and NY/NJ Harbor Estuary
- ✓ Endocrine disruption in Jamaica Bay winter flounder

Take home message from early work

- STPs in NY area putting out effluent that can be estrogenic to juvenile fish.
- Newly hatched fish are more sensitive than older fish
- The most estrogenic effluent was distinguished by having very high levels (100s of ug/L) of NPEOs
- NPEOs found at high levels in Jamaica Bay and elsewhere (10s of ppm in sediment) and are preserved in anoxic sediments.

Are fish living in New York waters being affected?

What are NPEOs?

Commercially important surfactants used primarily in industrial detergents, and emulsifiers.

Why are we concerned?

- Acutely toxic to marine organisms at 100-200 µg/L
- Weakly estrogenic 1000 to 10,000 less so than estrogen
- Can also inhibit enzymes involved in pollutant and steroid hormone metabolism

In Europe, NPEO use was largely stopped around 1986. Levels in wastewater were at acutely toxic levels. NPEO levels much lower now. Sales in US have risen steadily from 1965 – 1994 (the last year we have data for) to 300 x 10⁶ kg/yr. EPA about to release water quality criteria for US (~5 µg/L).

Winter Flounder – *Pseudopleuronectes americanus*

A great test species for contaminants in sediments

- Lives on and in the sediment eating benthic organisms – mostly worms and amphipods
- Has limited on/offshore migration, spending half (or more) of the year in shallow embayments where it spawns
- Eggs are demersal
- Young fish stay in shallows for at least their first year

An important fish for commercial and recreational fishing
Stocks in northeast have been in decline



Image from Renfro

Objectives

To assess whether or not the winter flounder in Jamaica Bay, NY are presenting evidence of endocrine disruption

Non-spawning adults



Embryos & larvae



Young-of-the-year juveniles (YOY)



Why study endocrine disruption in NY, particularly in Jamaica Bay?

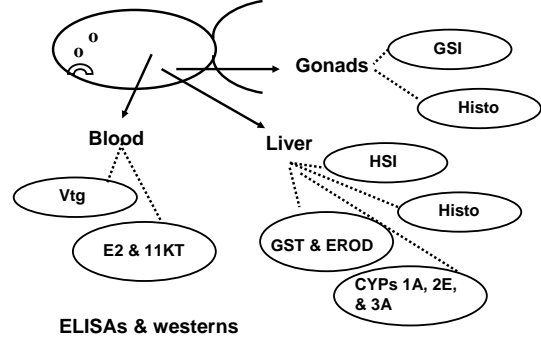
More than 14 Million people in metropolitan area

“Jamaica Bay is a sewage estuary”

- ✓ Up to 85% of freshwater input is sewage effluent
- ✓ Sediment concentrations of nonylphenol-ethoxylate metabolites (NPs) can range up to 50.0 ug/g (Ferguson et al.)
- ✓ Sediment concentrations of E2 + E1 can range up to 3.08 ng/g (Reddy et al.)



Analyses conducted



Summary of biochemical results in non-spawning adults

	Jamaica Bay		Shinnecock Bay	
	Males	Females	Males	Females
VTG (mg/ml)	0.066 ± 0.090	32 ± 18	0.071 ± 0.054	9.38 ± 5.5
11-KT (pg/ml)	441 ± 387	85 ± 23	377 ± 317	92 ± 86
E2 (pg/ml)	127 ± 66	380 ± 185	425 ± 49	373 ± 190
EROD (nmol/min/mg)	1.33 ± 0.65	1.76 ± 0.52	0.46 ± 0.31	0.44 ± 0.27
GST (nmol/min/mg)	1620 ± 122	1200 ± 160	1624 ± 260	1160 ± 330
CYP1A1*	212 ± 51	336 ± 91	135 ± 70	236 ± 5.76
CYP3A*	99 ± 16	132 ± 31	114 ± 14	116 ± 36
CYP2E*	96 ± 12	175 ± 44	88 ± 14	137 ± 90
Sex Ratio	1:12 (N=53)		1:1 (N=22)	

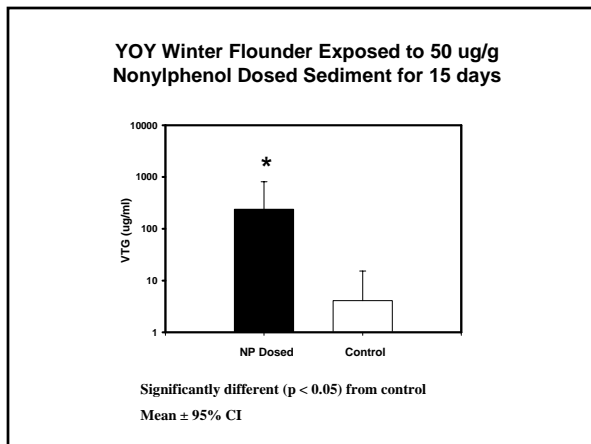
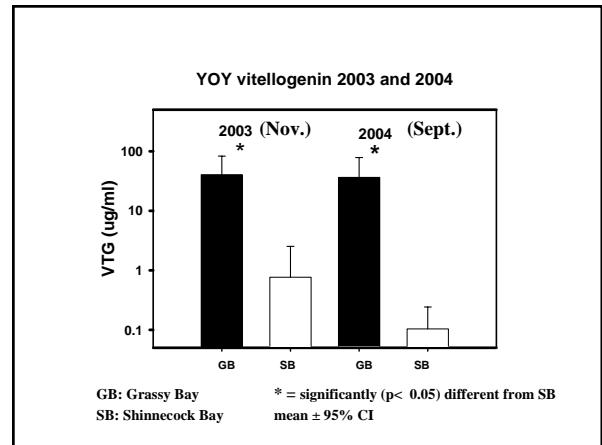
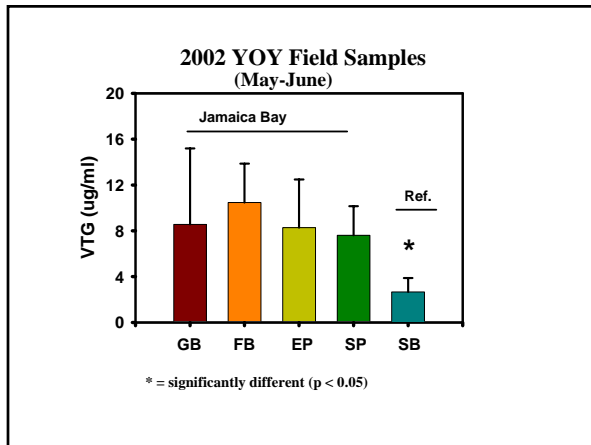
Red = significantly higher than reference (Shinnecock Bay)

Blue = significantly lower than reference (Shinnecock Bay)

* = relative OD/μg total protein

Non-spawning Adult Summary

- ✓ Male to female sex ratios are depressed in Grassy Bay compared to the reference site
- ✓ Female fish have elevated VTG, GSI and HSI but males do not
- ✓ Male fish from Grassy Bay have lower plasma estradiol and 11-KT
- ✓ Fish from Grassy Bay show altered CYP expression and activities



YOY Summary

- Jamaica Bay YOY winter flounder collections show elevated VTG for all 3 years sampled
- Similar elevation of VTG is also seen in NP exposed YOY
- Sex ratios are altered towards females
- NP dosed YOY seem to be more susceptible to parasites

Developmental delays seen in embryos exposed to Grassy Bay or NP dosed sediments

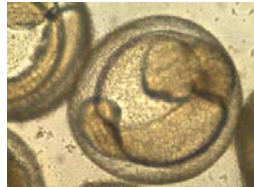


Control

100% reached 360° and hatched

Grassy Bay

100% Developmental arrest (210°) – none hatched



NP Dosed

90% Developmental arrest (210°)

10% Slow development (270°)

Conclusions

- ✓ Winter flounder in Jamaica Bay are clearly being affected by endocrine disrupting agents
- ✓ The responses in non-spawning adults suggests the influence of multiple and antagonistic agents
- ✓ Had we only looked at Vtg in adults males, we would have missed it
- ✓ Exposure during development is having pronounced effects on young fish in addition to elevating VTG (delayed development, reduced hatch, and larval survival and oovitellogenesis – possible immunosuppression)
- ✓ Likely that sediment NP plays a role
- ✓ These effects and sex ratio data suggest population level effects are likely

Recommendations:

- ✓ Evaluate management schemes to reduce inputs from wastewaters (restrictions on use of NPEOs, discharge limits, new treatment technologies)
- ✓ Conduct a more thorough evaluation of distribution, levels, and biological effects of endocrine active agents in Jamaica Bay
- ✓ Consider whether or not removal of sediments with high concentrations of endocrine disrupting compounds is warranted in hot spots such as Grassy Bay
- ✓ Consider action against other emerging contaminants such as polybrominated diphenyl ethers (PBDEs)