

Effects of Sedimentation on Winter Flounder Eggs in Laboratory Experiments

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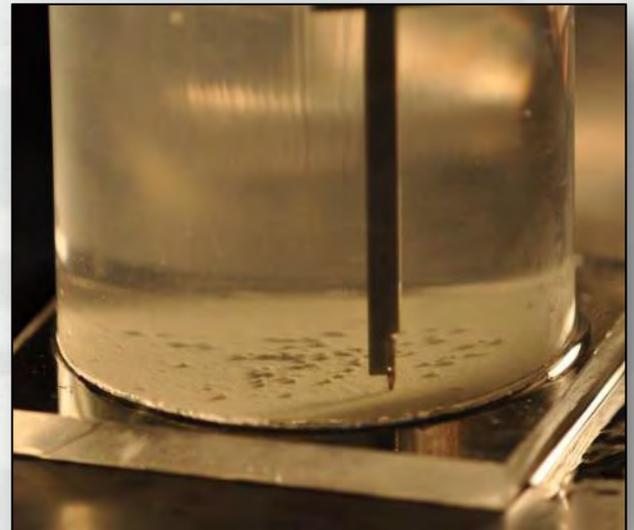
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Problem Statement

- Overlap of WFL spawning areas and dredging operations
- Effects of sedimentation important to dredging operations which commonly face EW restrictions
- Knowledge important for species for which EWs are designed to protect



Experimental Objective

Objective: Determine relationship of sedimentation to performance of WFL eggs under laboratory conditions

Key Questions:

- What depth results in unacceptable mortality?
- Is there a difference across three sediments?



Experimental Overview

- Experimental design developed with stakeholder guidance from USACE, NERDT and USEPA
- Experiments performed at ERDC laboratory
- Range finding experiments conducted in 2015 helped define exposure parameters for definitive experiments
- Data presented for 2016 experiments



Methods- Egg Source

- Wild broodstock collected in April near Middle Bank, Gulf of Maine
- Temperature 5.7-6.3 C
- Transported to UNH for spawning
- Test sediments used as natural declumping agent
- Eggs shipped overnight to ERDC



Methods- Eggs and Test Sediment

Sediment	Pre-shipment	Shipping Water quality upon arrival				Post-shipment
	Fertilized %	Temp (C)	D.O. (mg/L)	Salinity (ppt)	pH	Fertilized %
Patchogue	78.3 ± 8.0	3.7	42	28	7.16	54
Mianus	64.8 ± 3.0	4.8	33	30	7.30	62.5
Milford	87.4 ± 1.2	2.7	36	29	7.05	82.3

Sediment			
Particle Size (%)	Patchogue	Mianus	Milford
Sand	17	21	13
Silt	67	49	45
Clay	15	30	42

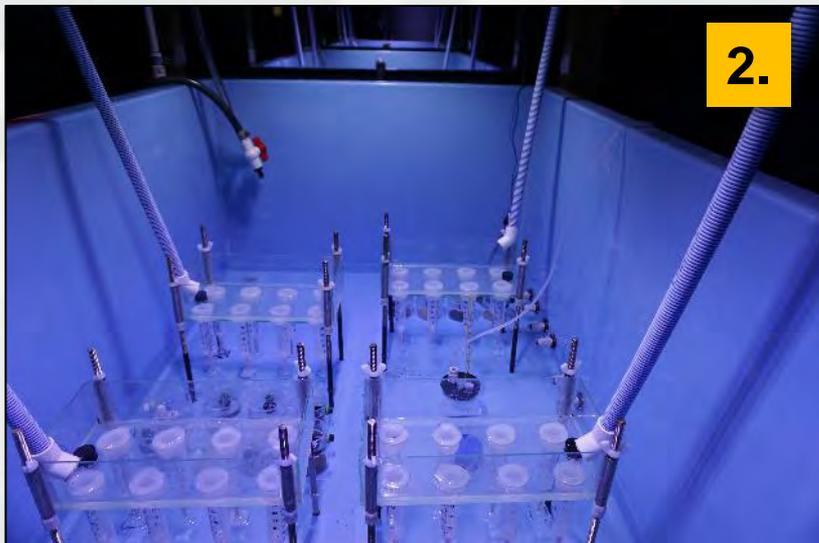
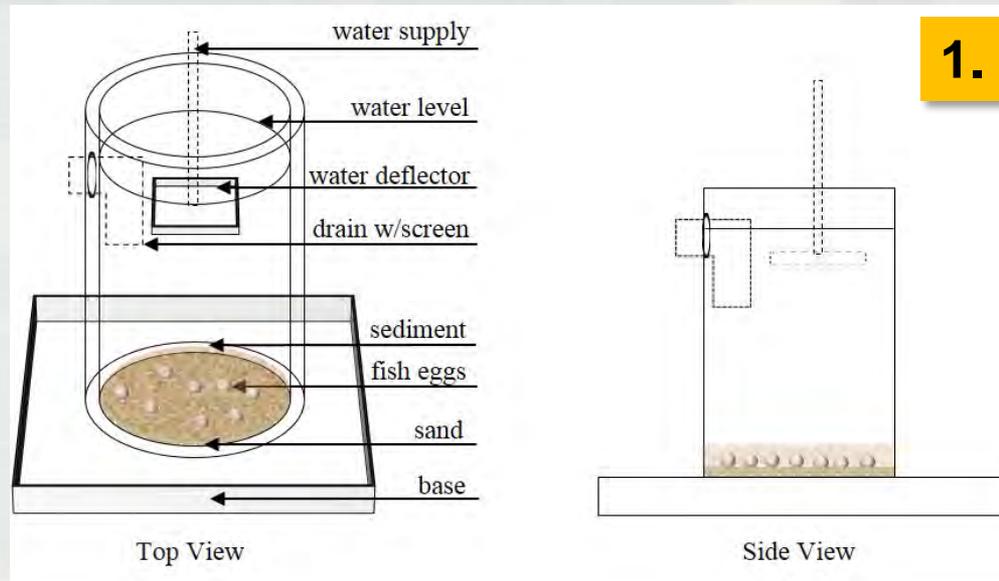
Methods- Experimental Design

Treatments: 0, 0.3, 0.6, 1.2, 3 mm sediment depth

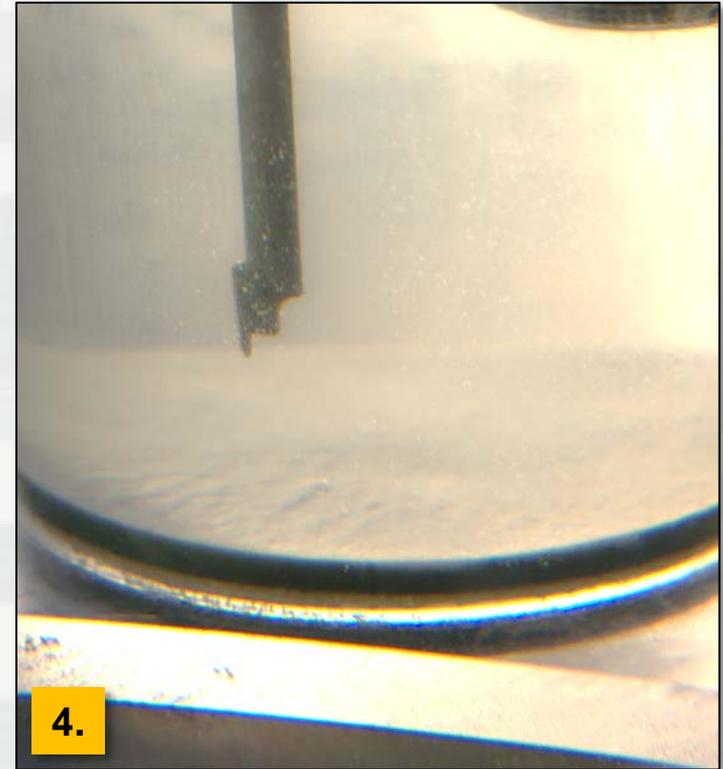
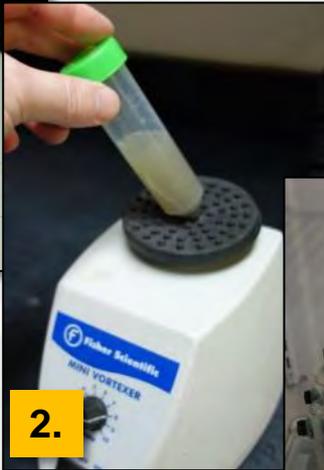
- WFL eggs from UNH
- Sediment collected from Patchogue, Mianus, & Milford
- Flow-through exposure regime using custom-designed experimental chambers (260 ml)
- Water temperature (5 C)
- Salinity (30 ppt)
- Light:Dark (12:12)
- 6 replicates/treatment; 50 eggs/replicate
- Chemical analysis of test sediments



Methods- Exposure Design

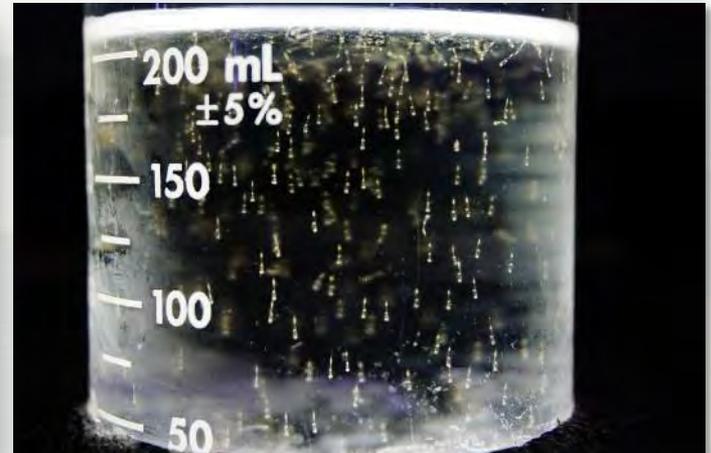
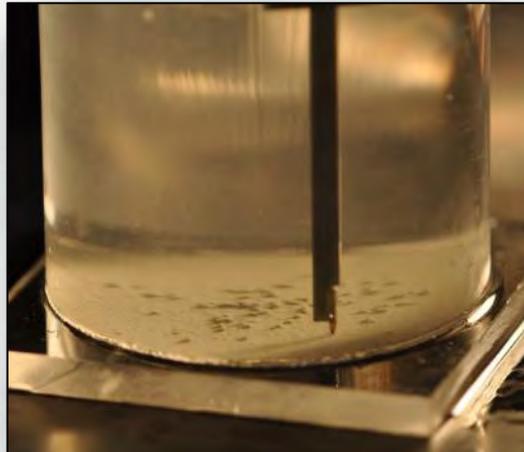
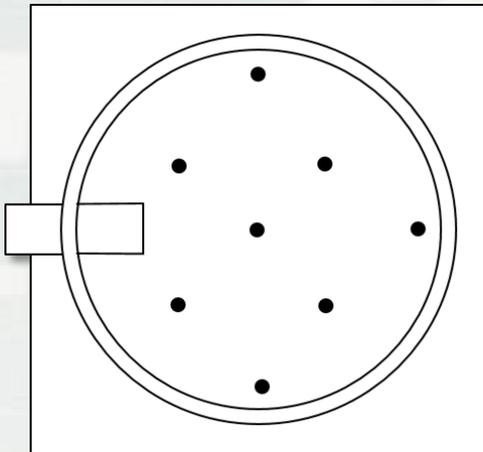


Methods- Introduce Sand, Sediment & Eggs



Methods- Measurements

- Sediment depth (minus sand depth) measured 24 h after settling
 - ▶ Within chamber sediment depth quantified
- Water quality monitored daily
- Exposure completed when no larval fish observed to hatch after 72 h observation
- Duration of exposure varied dependent on sediment



Results- Measured Sediment Depth

Sediment	Nominal Depth	24 h Depth	Settle Time (days)	End Depth	Change (%)	Sand Depth
Mianus River	0	0	21	0	0	1.04 (0.04)
	0.3	0.25 (0.06)	27	0.22 (0.06)	-13	1.08 (0.06)
	0.6	0.46 (0.03)	25	0.37 (0.03)	-19	1.07 (0.04)
	1.2	1.22 (0.08)	23	0.94 (0.06)	-23	1.00 (0.04)
	3	2.76 (0.07)	22	2.11 (0.09)	-24	1.05 (0.04)
Milford Harbor	0	0	20	0	0	1.06 (0.05)
	0.3	0.27 (0.04)	22	0.18 (0.06)	-31	1.05 (0.07)
	0.6	0.51 (0.07)	22	0.4 (0.05)	-23	1.05 (0.04)
	1.2	1.05 (0.05)	21	0.75 (0.08)	-28	1.08 (0.05)
	3	2.81 (0.06)	21	2.19 (0.06)	-22	1.08 (0.03)
Patchogue River	0	0	20	0	0	0.98 (0.07)
	0.3	0.35 (0.03)	24	0.34 (0.05)	-3	1.01 (0.05)
	0.6	0.55 (0.04)	24	0.52 (0.08)	-6	1.00 (0.04)
	1.2	1.31 (0.07)	23	1.08 (0.07)	-17	0.99 (0.04)
	3	3.01 (0.06)	20	2.54 (0.05)	-16	0.99 (0.05)

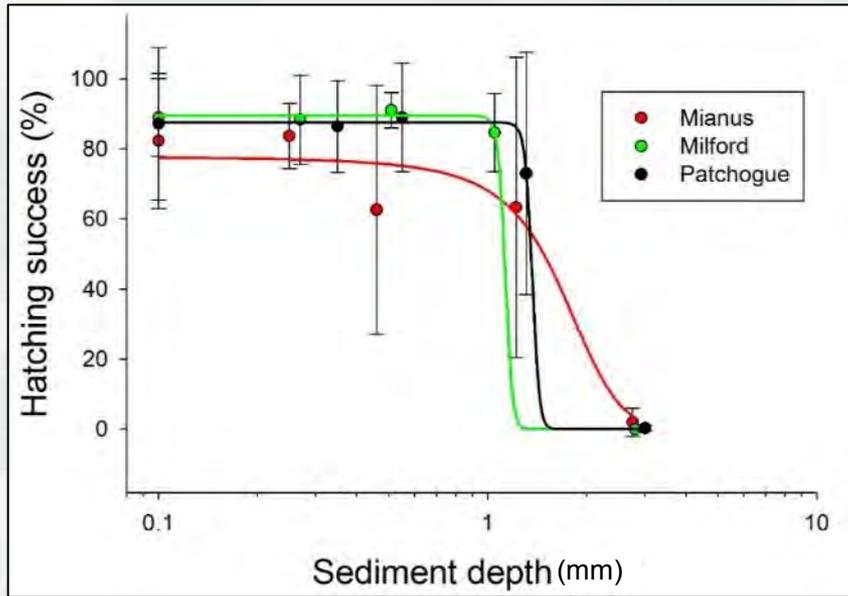
Results- Water Quality

Sediment	Treatment	Salinity (ppt)	pH	Temp (C)	D.O. (mg/L)	Min D.O. (mg/L)	Max D.O. (mg/L)
Mianus	0				8.14	5.07	9.02
	0.3				8.30	6.75	10.94
	0.6	30.92 (0.07)	7.85 (0.04)	5.34 (0.03)	6.84	2.04	10.92
	1.2				6.88	0.88	8.89
	3				5.73	1.2	8.9
Milford	0				7.24	3.83	9
	0.3				7.66	5.45	10.13
	0.6	30.68 (0.13)	8.21 (0.01)	5.24 (0.07)	7.66	3.09	10.27
	1.2				6.27	3.5	9.35
	3				4.08	1.71	8.76
Patchogue	0				8.05	5.75	9.46
	0.3				7.41	2.54	9.37
	0.6	31.16 (0.10)	7.82 (0.02)	5.17 (0.04)	7.75	5.05	9.48
	1.2				7.17	3.2	9.3
	3				4.73	2.33	8.95

Results- Hatching Success

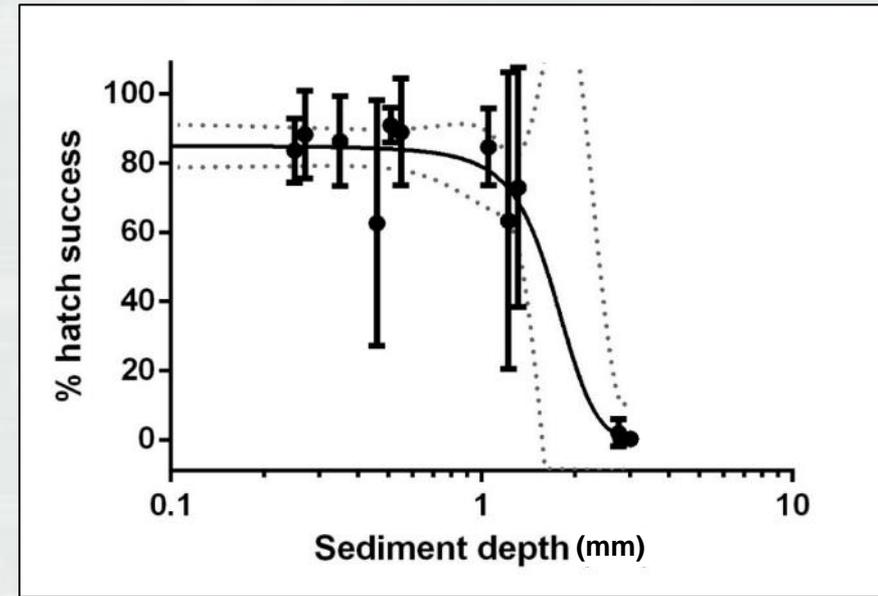
Three test sediments plotted individually

A



Three sediments combined

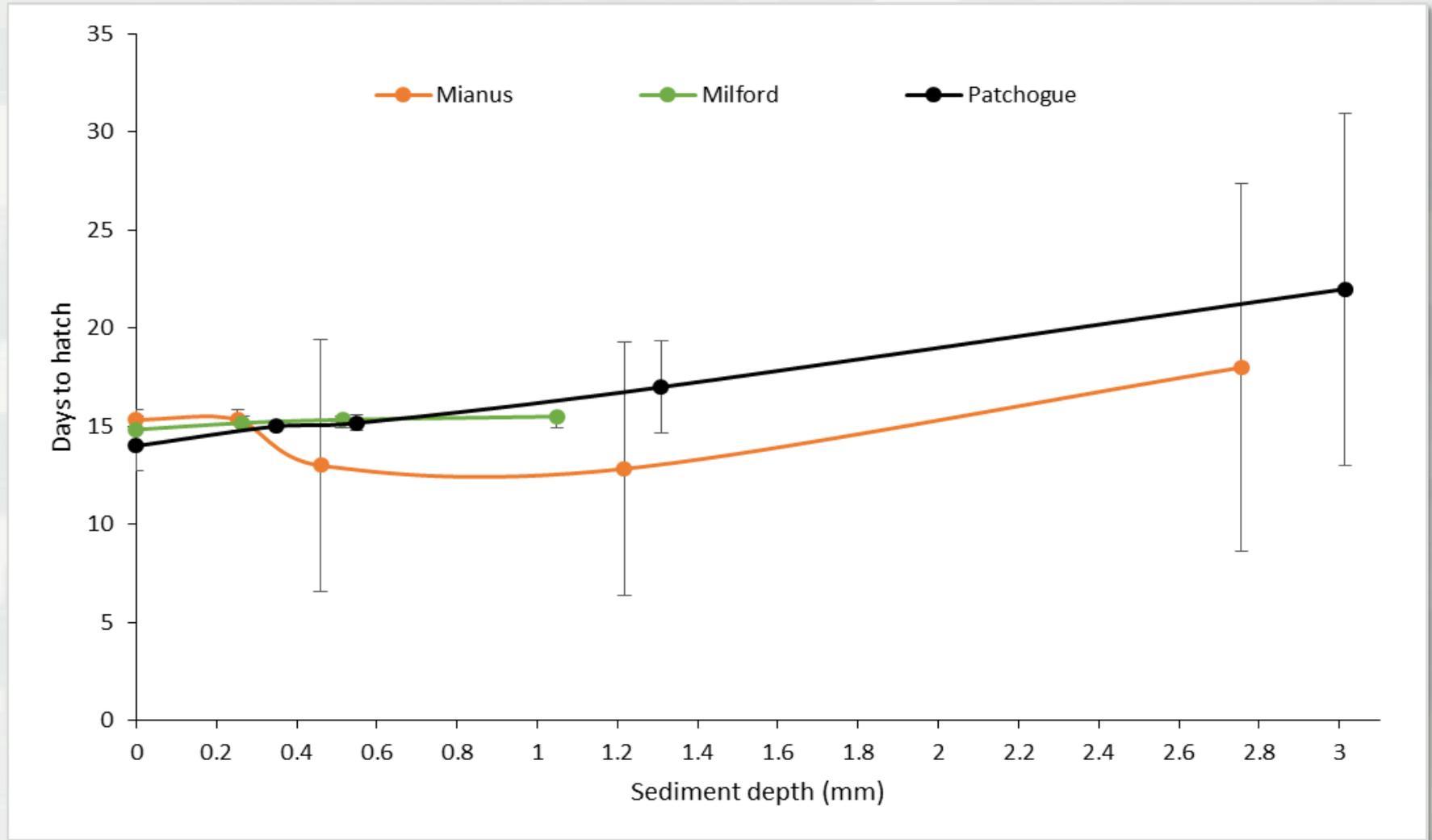
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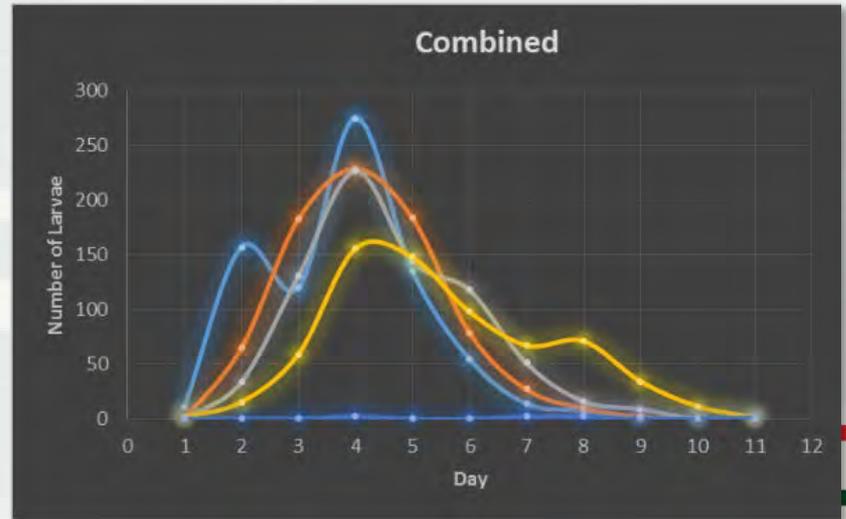
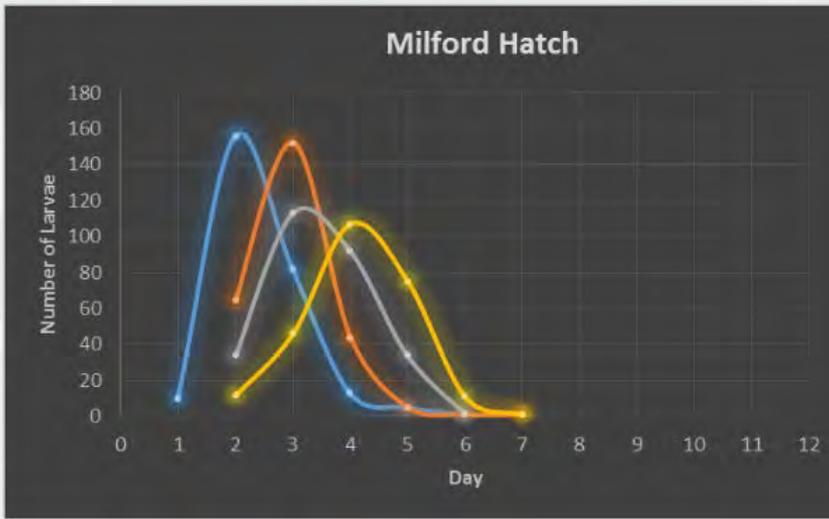
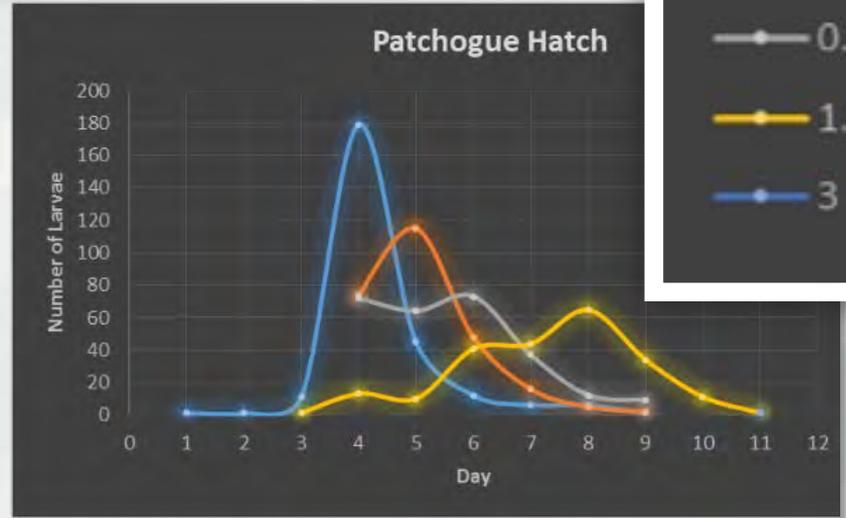
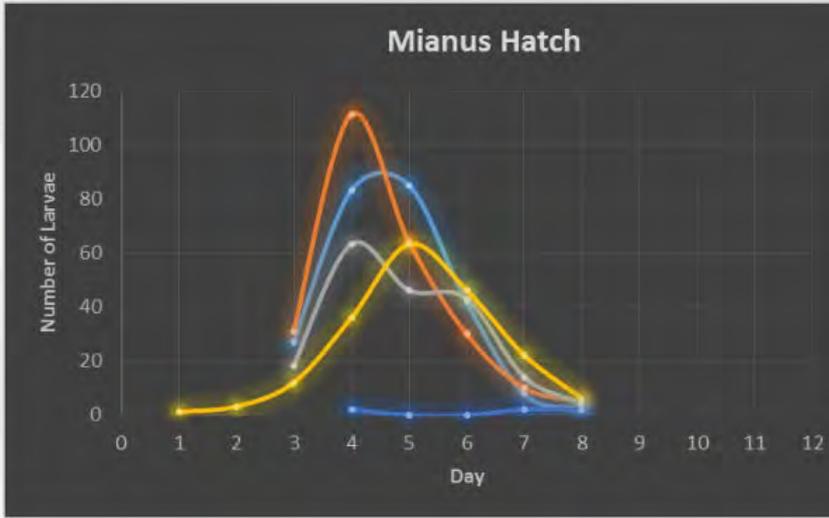
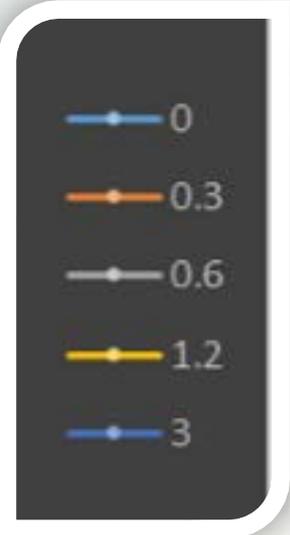
Mean +/- one standard deviation around the mean. Dotted line represents 95% confidence interval.



Results- Days to Hatch



Results- Length of Hatch



Results- Summary

Sediment	NOEC	LOEC	EC5	EC10	EC50
Mianus	1.22	2.76	0.76 (0.00 – 1.18)	0.98 (0.01 – 1.42)	1.56 (0.64 – 3.60)
Milford	1.05	2.81	1.05 (0.95 – 1.14)	1.19 (1.09 – 1.28)	1.72 (1.63 – 1.80)
Patchogue	1.31	3.01	1.12 (1.08 -1.16)	1.22 (1.19 – 1.26)	1.58 (1.53 – 1.64)
<u>Combined</u>	1.31	2.76	1.06 (0.91 – 1.17)	1.17 (1.03 – 1.28)	1.59 (1.33 – 1.91)

Summary

- WFL hatching not affected up to 1.2 mm sediment depth across three sediments examined
- Significant mortality occurred at 3 mm depth for all three sediments
- Overall there was no statistical difference in WFL performance among the three sediments
- Establishes scientific foundation for sedimentation effects on hatching success of WFL eggs
- Relevancy of the results need to be validated in the field near a dredge operation to assess risk



Acknowledgements

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