Fish production & habitat use in a large-scale wetlands restoration project

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Background

Comprehensive monitoring program to evaluate progress and success of wetland restoration efforts in Delaware Bay

Marsh fish assemblage monitoring to evaluate faunal response to the restoration activities

- Provide quantitative data on fish species composition, relative abundance, life history stage, size and growth by habitat
- Comparison to reference marshes as "measure" of success

Monitoring of representative restoration sites and two reference marshes

- Lower Bay Region
  - Commercial & Dennis Township Restoration Sites
  - Formerly-diked salt hay farms
  - Moores Beach Reference Marsh
  - Sampling at Dennis Township Restoration Site ended in 2005
  - Generally mesohaline portion of estuary (5-18 ppt)
- Upper Bay Region
  - Alloway Creek & Cohansey River Watershed Restoration Sites
  - Formerly *Phragmites*-dominated sites
  - Mad Horse Creek Reference Marsh
  - Generally oligohaline portion of estuary (0-5 ppt)

Additional special studies focused on feeding, growth, survival and production of marsh fish assemblages (see published literature)

This analysis focuses on long-term data for the lower bay restoration sites & the adjacent reference marsh

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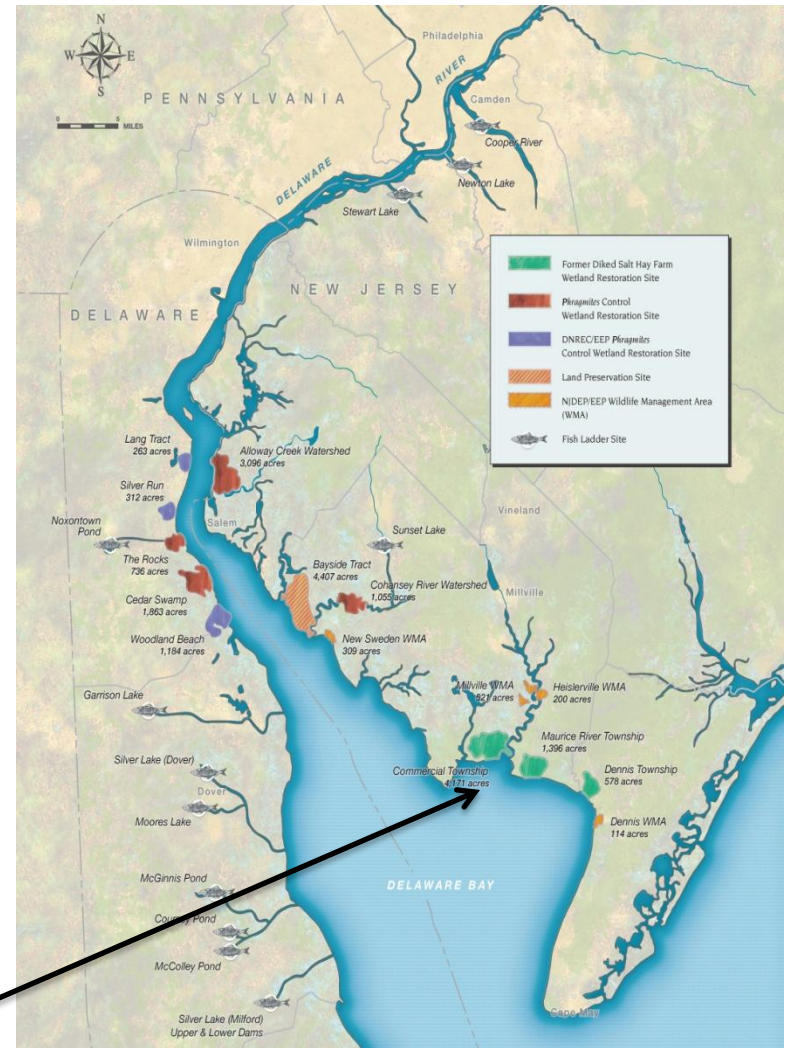
Lower Delaware Bay Sampling Sites
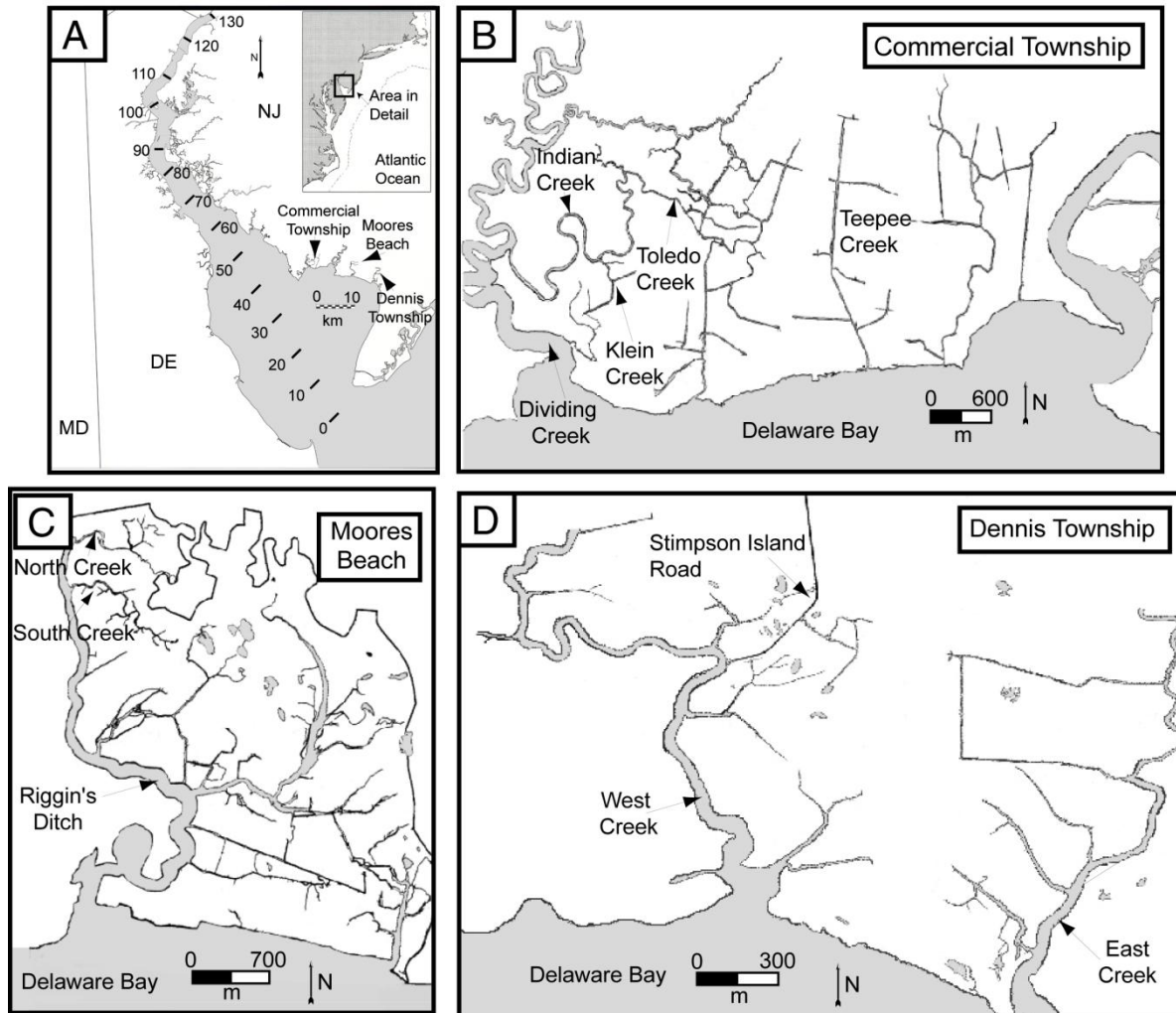
Delaware Bay (A) sampling sites including the Commercial and Dennis Township Wetland Restoration Sites (B, D) and the Moores Beach Reference Marsh (C)

Sub-tidal Sampling Methods

Sampled two large marsh creeks per site using a 4.9 m (16 ft.) semi-balloon otter trawl with 6.0 mm (0.25 inch) cod end mesh.

- Sampled at three locations per creek: upper (U), lower (L), and mouth (M)
- Mouth of a creek defined as intersection with the next higher order creek
- Three two-minute tows per location around high tide

Tows against current at standardized speed of 1.4 m/s (6 ft/s)

Diurnal monthly sampling May – Nov. during spring tides

Fish identified, enumerated, up to 50 individuals per species per sample measured

Intertidal Sampling Methods

Sampled two intertidal creeks per site using 1.8 m x 1.2 m x 1.2 m (6 ft. x 4 ft. x 4 ft.) weirs, with 4.5 m x 1.8 m (15 ft. x 6 ft.) wings

- 3.175 mm (0.125 inch) mesh
- Set at high tide & hauled at low tide

Diurnal monthly sampling May – Nov. during spring tides

"Leaded" net line buried in the bottom sediment to eliminate gaps in the weir

- Fish remaining in front of net seined into the weir when creek draining incomplete

Fish identified, enumerated, up to 50 individuals per species per sample measured

Physical and Sampling Summary

Site	Wetland Type	Area (ha)	Sampling Frequency (May-Nov.)	Sampling Duration[1]	Mean distance of trawling stations from bay (km)	Mean depth range at trawling stations (m)	Number of samples Subtidal (trawls)	Intertidal (weirs)
Commercial Township	Salt Hay Farm Restoration	1688	Monthly	1997-2011	Upper sites 4.5 Lower sites 2.7	2.46	2149	196
Dennis Township	Salt Hay Farm Restoration	234	Monthly	1997-2005	0.97	1.82	1418	126
Moores Beach	Reference	521	Monthly	1997-2011	1.35	1.87	2189	210

[1]Additional samples from 1996, night-time events, & other months not included in this analysis

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Selected Physical Parameters at Sampling Sites

Mean monthly values for selected physical parameters at restored and reference marshes.
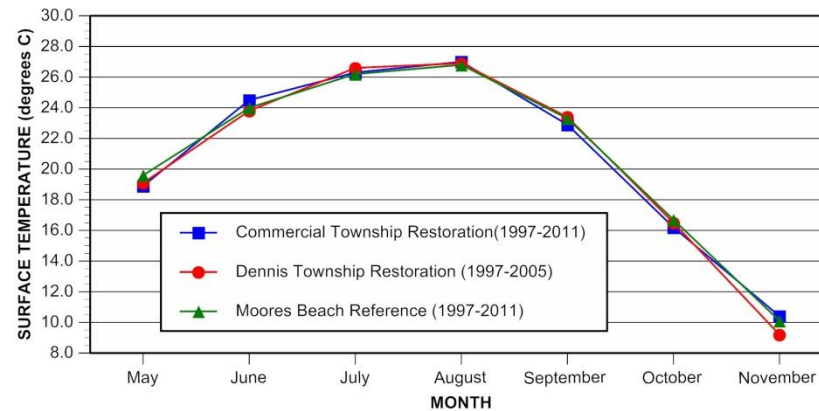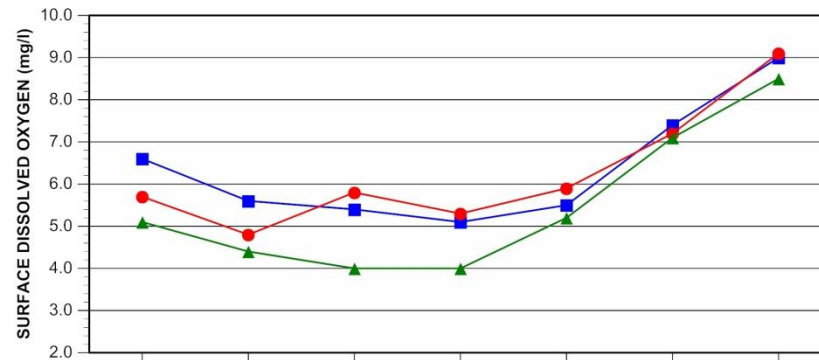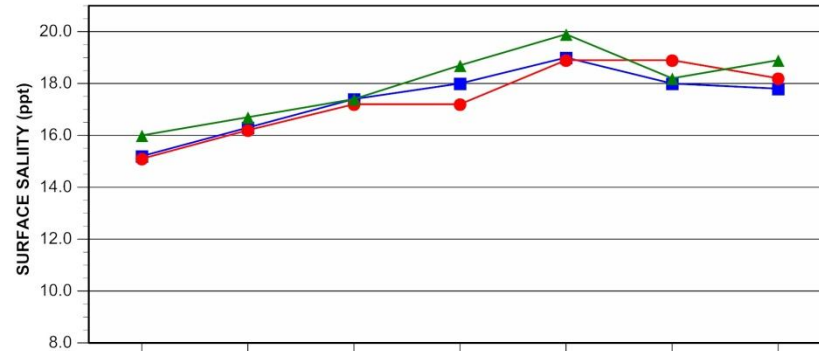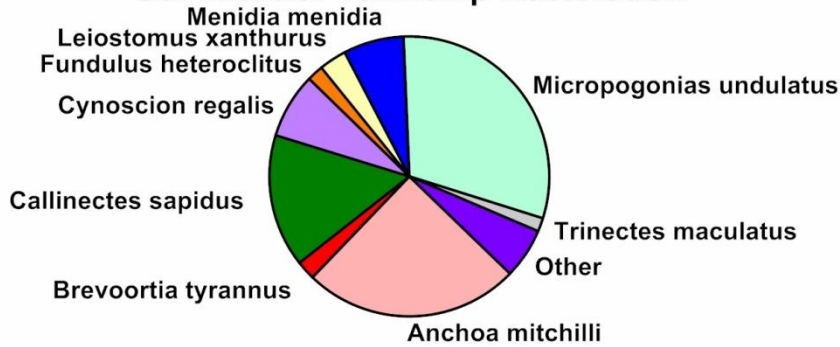
Total Catch by Sampling Site and Gear

Total catch for intertidal (weir) & subtidal (trawl) sampling during 1997-2011 at restored (CT=Commercial Township; DT= Dennis Township) and reference (MB=Moores Beach) marshes. Species with total catch <10 not shown. (>582,000 specimens examined)

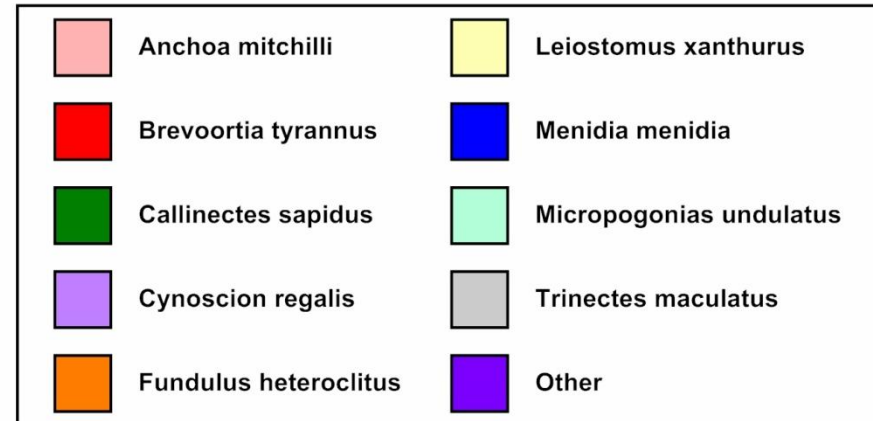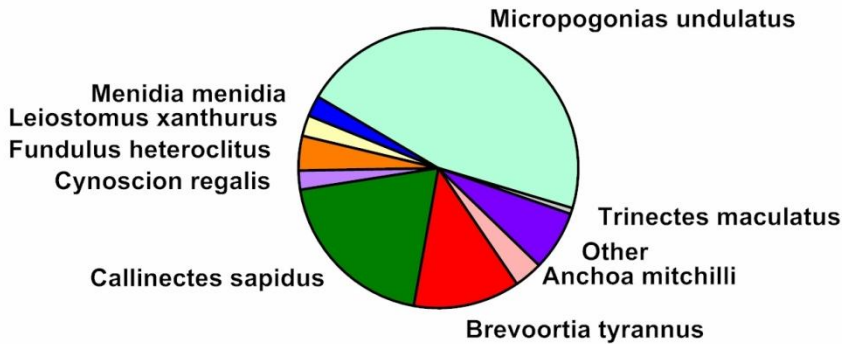| SPECIES	Otter Trawl			Weir		
	CT	DT	MB	CT	DT	MB
Alosa aestivalis	164	632	123	170	14	3
Alosa mediocris	4	4	7		1	
Alosa pseudoharengus	209	322	421	46	27	
Alosa sapidissima	10	6	13			
Anchoa mitchilli	15,817	5,085	1,782	885	6,721	42
Anguilla rostrata	210	200	62	1	5	35
Bairdiella chrysoura	165	116	87	46	15	
Brevoortia tyrannus	1,360	2,406	6,689	679	7,312	147
Callinectes sapidus	9,535	12,693	10,751	2,786	3,303	4,110
Centropristis striata		16	26			
Clupea harengus	10	7	1			
Clupeidae sp.	13	39	928	50	12	
Cynoscion regalis	4,678	3,455	1,188	43	602	9
Cyprinodon variegatus	6	16	2	75	665	2,615
Dorosoma cepedianum	64	5	10			4
Etropus microstomus	3	8	1			
Fundulus heteroclitus	1,156	932	2,154	36,206	40,599	78,773
Fundulus luciae					1	13
Fundulus majalis	7	10	14	17	15	13
Gambusia holbrooki					15	
Gobiosoma bosc	63	78	66	9	41	2
Leiostomus xanthurus	1,968	5,265	1,274	577	1,410	326
Limulus polyphemus	471	390	231		6	2
Malaclemys terrapin	54	116	151		1	
Menidia beryllina	9			4	27	66
Menidia menidia	4,295	880	1,330	34,165	98,963	26,638
Menticirrhus saxatilis	111	31	16			
Micropogonias undulatus	20,988	42,999	25,015	505	35,092	170
Morone americana	635	256	399	6		15
Morone saxatilis	307	134	628	9	1	29
Morone sp.	26	5	6	1		
Mugil cephalus			2		14	
Mugil curema	2	5	7	17	1	1
Ophidion marginatum	45	115	18			
Opsanus tau	24	20	41			
Paralichthys dentatus	58	48	53			
Pogonias cromis	858	373	198	330	106	69
Pomatomus saltatrix	9	15	19		1	
Prionotus carolinus	5	7				
Prionotus evolans	11	15	1			
Pseudopleuronectes america	34	59	15			
Sciaenidae sp.	7	3		26		
Syngnathus fuscus	43	27	12		8	
Trinectes maculatus	991	1,679	389			
Unidentified fish	1	3			15	1
Urophycis regia	23	30	158			
TOTAL	64,449	78,505	54,288	76,653	194,993	113,083
OTHERS	32	21	23	12	14	0
Grand Total	64,481	78,526	54,311	76,665	195,007	113,083

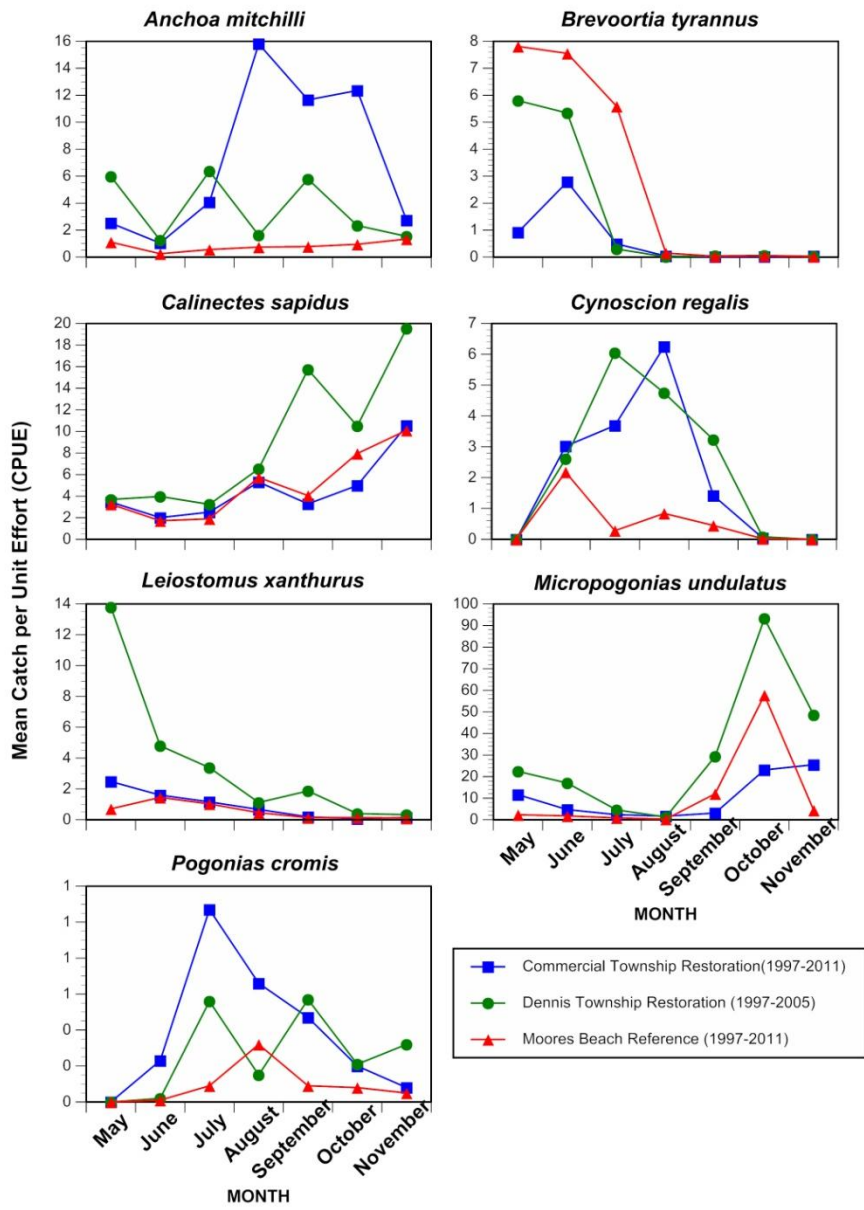Commercial Township Restoration

Dennis Township Restoration
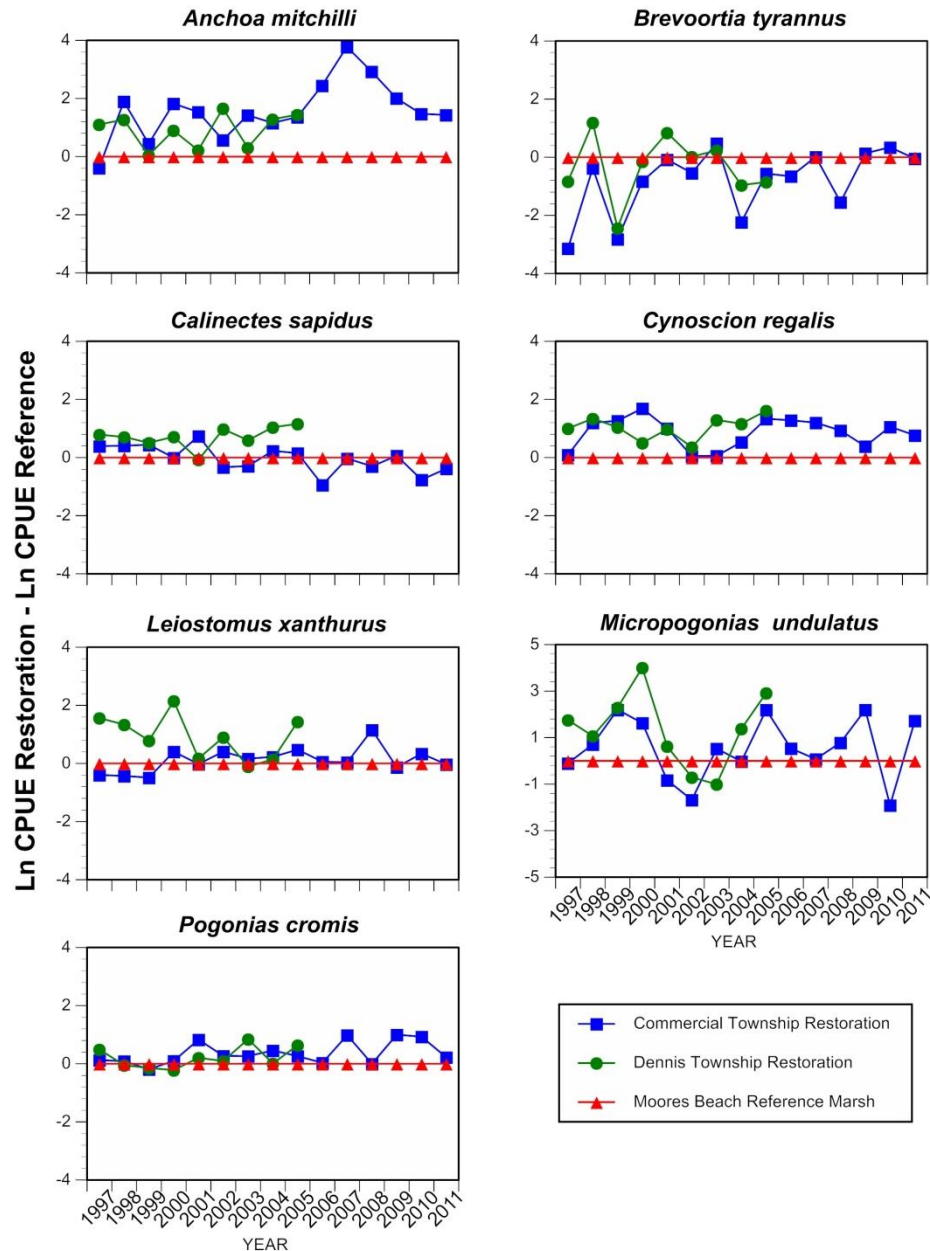

Moores Beach Reference

Monthly Abundance in Subtidal Habitat (1997-2011)

Monthly abundance (catch per unit effort, CPUE) of most abundant species collected with trawls at restored and reference marshes.
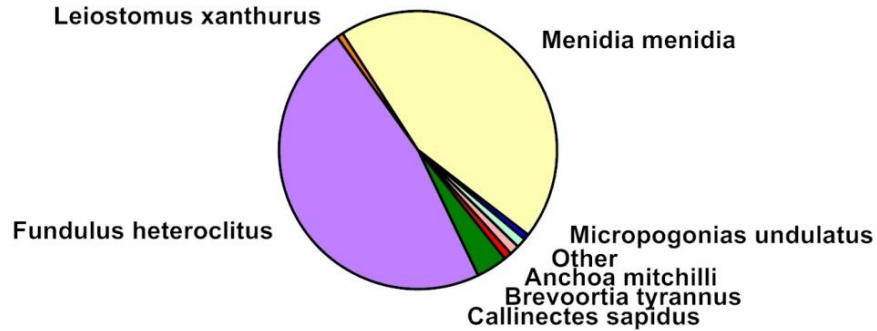
Comparative abundance (catch per unit effort, CPUE) of most abundant species collected with bottom trawls at restored and reference marshes.
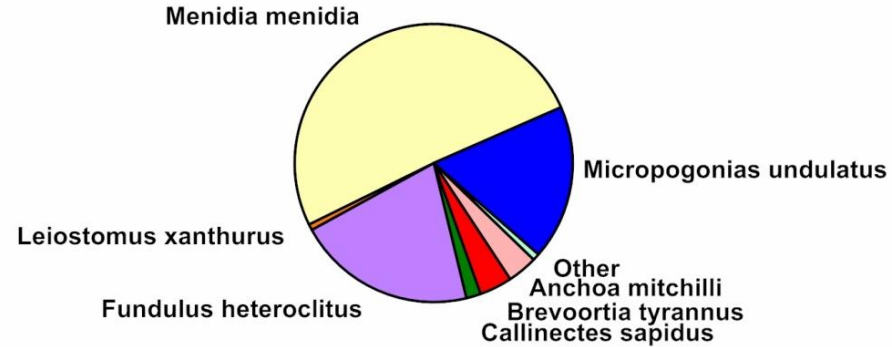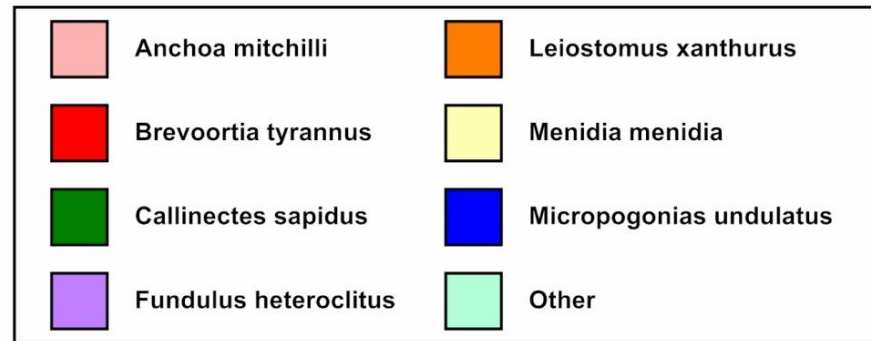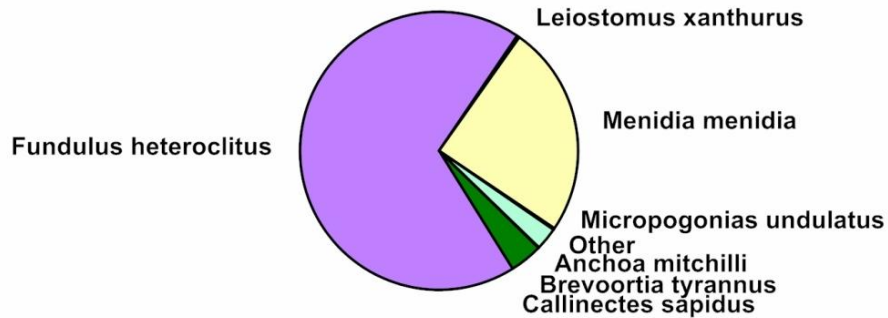
Commercial Township Restoration

Dennis Township Restoration

Moores Beach Reference

Legend:
- Anchoa mitchilli
- Brevoortia tyrannus
- Callinectes sapidus
- Fundulus heteroclitus
- Leiostomus xanthurus
- Menidia menidia
- Micropogonias undulatus
- Other

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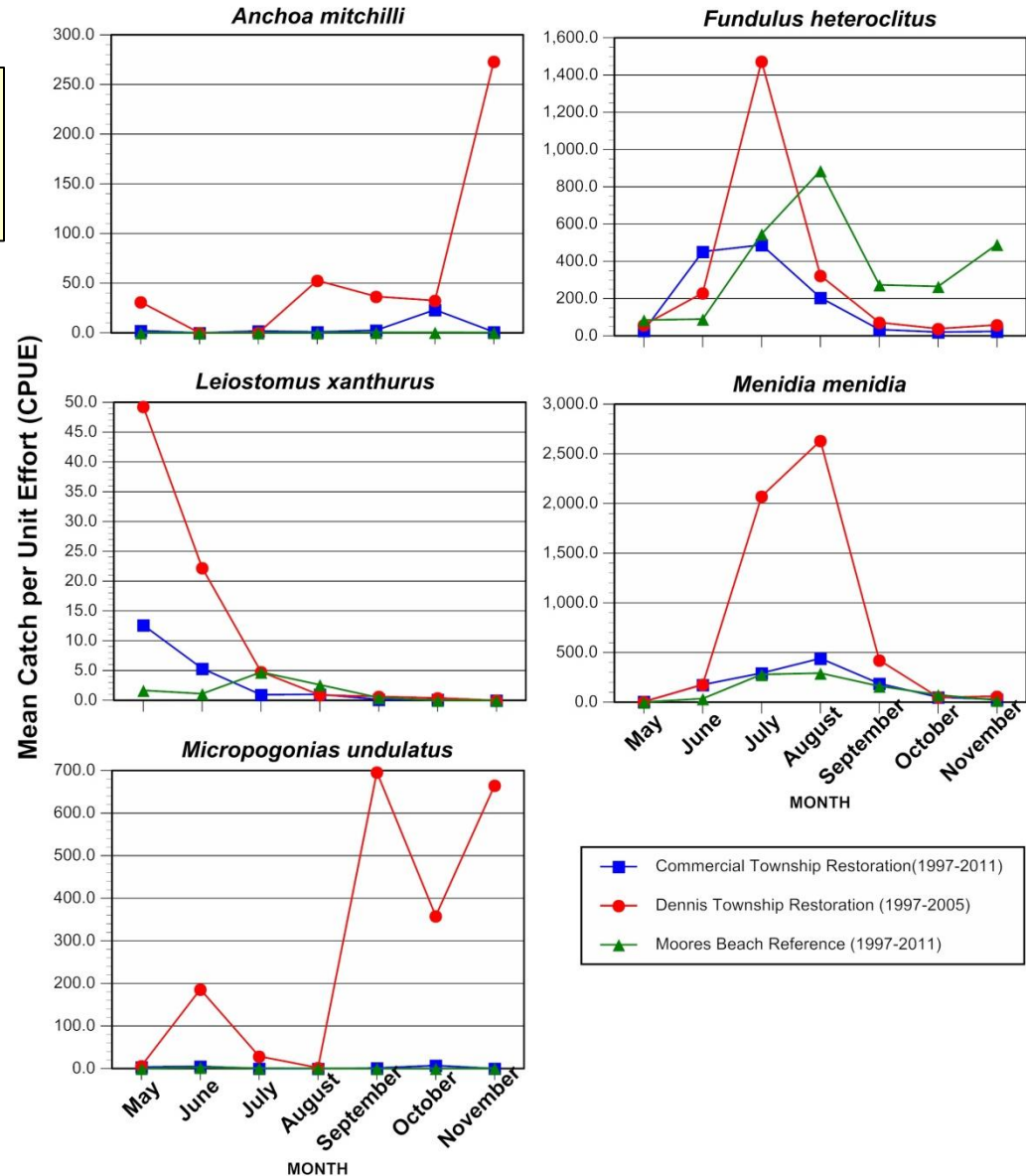
Monthly Abundance in Intertidal Habitat (1997-2011)

Monthly abundance (catch per unit effort, CPUE) of most abundant species collected with weirs at restored and reference marshes.

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Comparative Abundance in Intertidal Habitat (1997-2011)

Comparative abundance (catch per unit effort, CPUE) of most abundant species collected with weirs at restored and reference marshes.
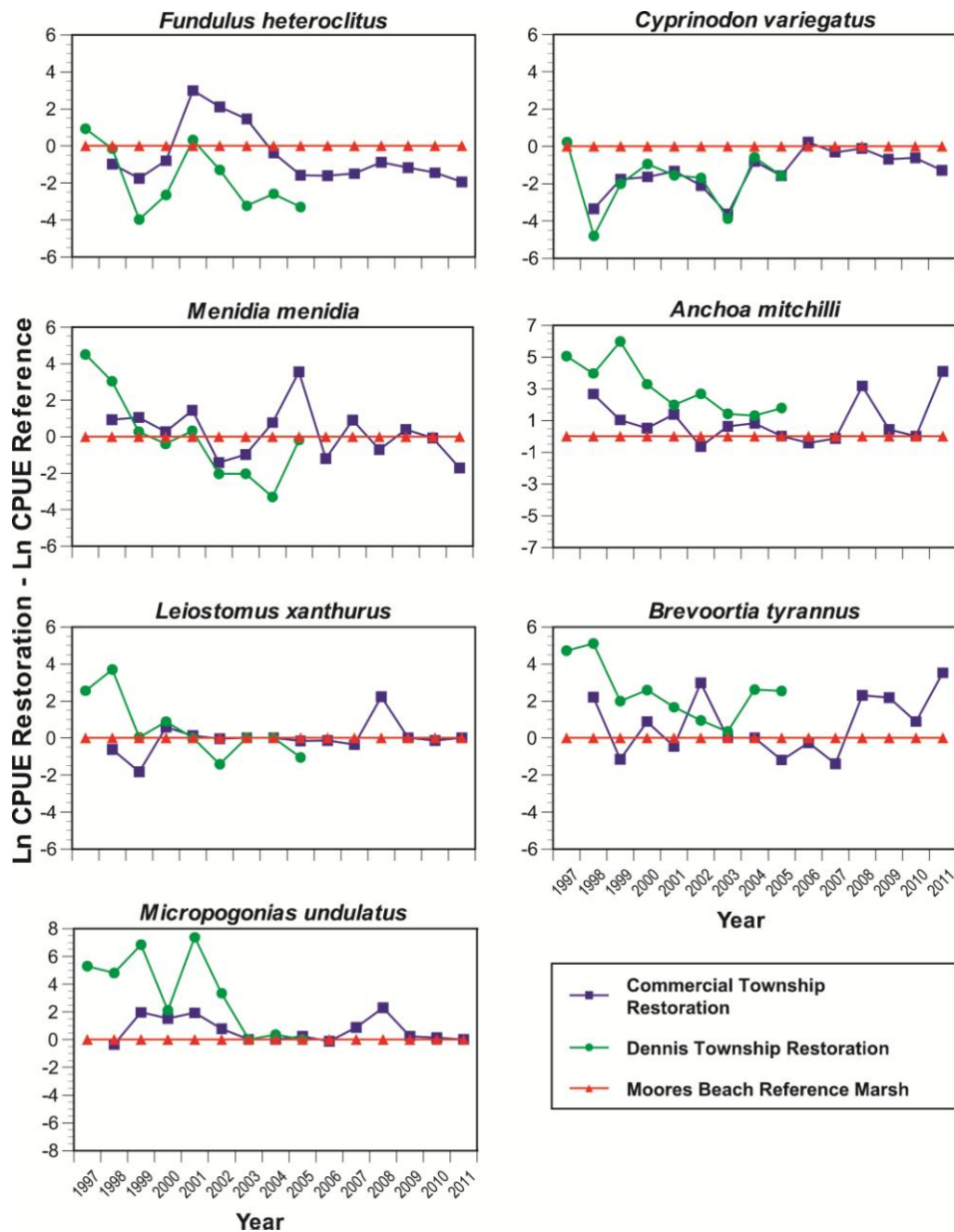
Conclusions

There is extensive use of the restored marshes by Delaware Estuary fisheries

- 15-year dataset comparing restored to reference marshes provides long-term evaluation of success of restoration efforts

Resident & transient species responded quickly & dramatically to opening of restored marshes to tidal flow

Species composition between restored & reference marshes comparable

- Subtle differences reflective of sample location & differences in distance of sampling locations from open water of Delaware Bay

Pattern of habitat use varies by species and season

- Pattern for transient species reflects timing of recruitment to Estuary & size-dependent vulnerability to sampling gear
- Pattern for resident species reflects seasonality of spawning & size-dependent vulnerability to sampling gear

Subtidal and intertidal sampling data indicates that restored marshes function like the adjacent reference marsh

Additional special studies focused on feeding, growth, survival and production of marsh fish assemblages document that structural & functional attributes of restored marshes equivalent to "natural" marshes

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