

The following supplements accompany the article

Priming the larval pump: resurgence of bay scallop recruitment following initiation of intensive restoration efforts

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Supplement 1. Table S1. Sampling sites of bay scallop *Argopecten irradians irradians* larval recruitment in the Peconic Bays, New York, USA, 2005 to 2010. Bottom type—S: sand; M: mud; MS: muddy sand; Sh: shell hash; Ma: macroalgae; Cf: *Crepidula fornicata* barrens; Gr: gravel; E: eelgrass

Orient Harbor

<u>Site Name</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Depth (m) at MLW</u>	<u>Bottom Type</u>
East Marion	41°07.714'W	72°19.641'W	1.3	S/Sh/Ma
Longlines	41°08.282'N	72°18.937'W	4.5	M
Peter's Neck	41°07.697'N	72°17.521'W	1.3	S
Inside Long Beach	41°07.352'N	72°17.532'W	4	MS/M/Sh/Ma
Outside Long Beach	41°06.766'N	72°17.682'W	3	S/Sh/Cf
Central Orient	41°07.289'N	72°18.296'W	6.3	M
Hay Beach	41°06.308'N	72°19.555'W	1.7	S/E/Ma/Sh
Greenport Jetty	41°06.347'N	72°20.892'W	3.5	MS/Sh/Ma

Southold Bay

<u>Site Name</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Depth (m) at MLW</u>	<u>Bottom Type</u>
Southold Bay	41°03.966'N	72°24.203'W	3	MS/Sh/Ma

Hog Neck Bay

<u>Site Name</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Depth (m) at MLW</u>	<u>Bottom Type</u>
Hog Neck Bay	41°01.610'N	72°24.110'W	3	S/Sh/Ma

Hallock Bay

<u>Site Name</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Depth (m) at MLW</u>	<u>Bottom Type</u>
Narrow River	41°08.197'N	72°16.840'W	1.5	M/Sh/Ma
Bulkhead	41°08.251'N	72°16.396'W	1.7	M/MS/Ma
John's site	41°08.287'N	72°15.799'W	1.7	MS/Sh/Ma
Inside Little Bay	41°08.191'N	72°15.491'W	1.3	M/Sh/Ma
Outside Little Bay	41°08.012'N	72°15.824'W	2	MS/Sh/Ma
Central Flats	41°07.951'N	72°16.389'W	1.7	S/Ma

Northwest Harbor

<u>Site Name</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Depth (m) at MLW</u>	<u>Bottom Type</u>
Offshore Cedar Point	41°02.099'N	72°15.349'W	2	S/Sh/Ma
Inshore Cedar Point	41°02.251'N	72°15.416'W	2.5	S/Sh/Cf/Ma
NE Corner	41°02.454'N	72°14.535'W	4	M
SWG	41°01.806'N	72°14.596'W	2	S/Sh/Ma
St. Regis	41°01.519'N	72°14.889'W	2.5	MS/Sh/Ma
Barcelona Neck	41°00.873'N	72°15.389'W	3	MS/Sh
E Sag Harbor	41°01.055'N	72°16.000'W	4	S/Sh/Ma
Sag Harbor	41°00.410'N	72°17.419'W	2	S/Sh/Ma

Supplement 2. Bay scallop *Argopecten irradians irradians* larval dispersion model

Our discussion of larval dispersion from the spawner sanctuary in Orient Harbor and elsewhere in the Peconic Bays is largely based on Siddall et al. (1986); we summarize this work here (by permission of the authors) and include a composite figure adapted from several figures presented in their report to illustrate patterns which informed our conclusions. The larval dispersion model of Siddall et al. (1986) consists of 2 parts: (1) a hydrographic model that utilizes field observations to calculate horizontal currents (a vertically averaged model was used because of the well mixed nature of the water column) and (2) dispersion modeling simulating the transport of passive particles (as a proxy for scallop larvae) from specified release points, at particular tidal stages, over varying time periods. Important assertions/assumptions of the model are: (1) because the estuarine system is well mixed vertically it can be modeled adequately without knowledge of vertical depth regulation by larvae; (2) synchronous spawning of adult scallops at 3 primary planting locations in Orient Harbor (OH), Northwest Harbor (NW), and Flanders Bay (FB) is assumed to occur at specific times during late May to late June (which largely agrees with our observations); and (3) the model is based on tidal forcing and does not include less predictable meteorological events.

Fig. S1 illustrates dispersal patterns after 4, 8, 10, 12, and 14 d; the latter is when bay scallop larval settlement is expected to occur. Transport of particles released from within FB is largely within that system, but dispersal is more widespread from release points in OH and NW. The authors also modeled larval transport from release points in other embayments and noted considerable export of larvae from Sag Harbor (SH) and OH to Southold Bay (SB), and a notable lack of larval dispersal from a site in Hog Neck Bay (HN) near our sampling station.

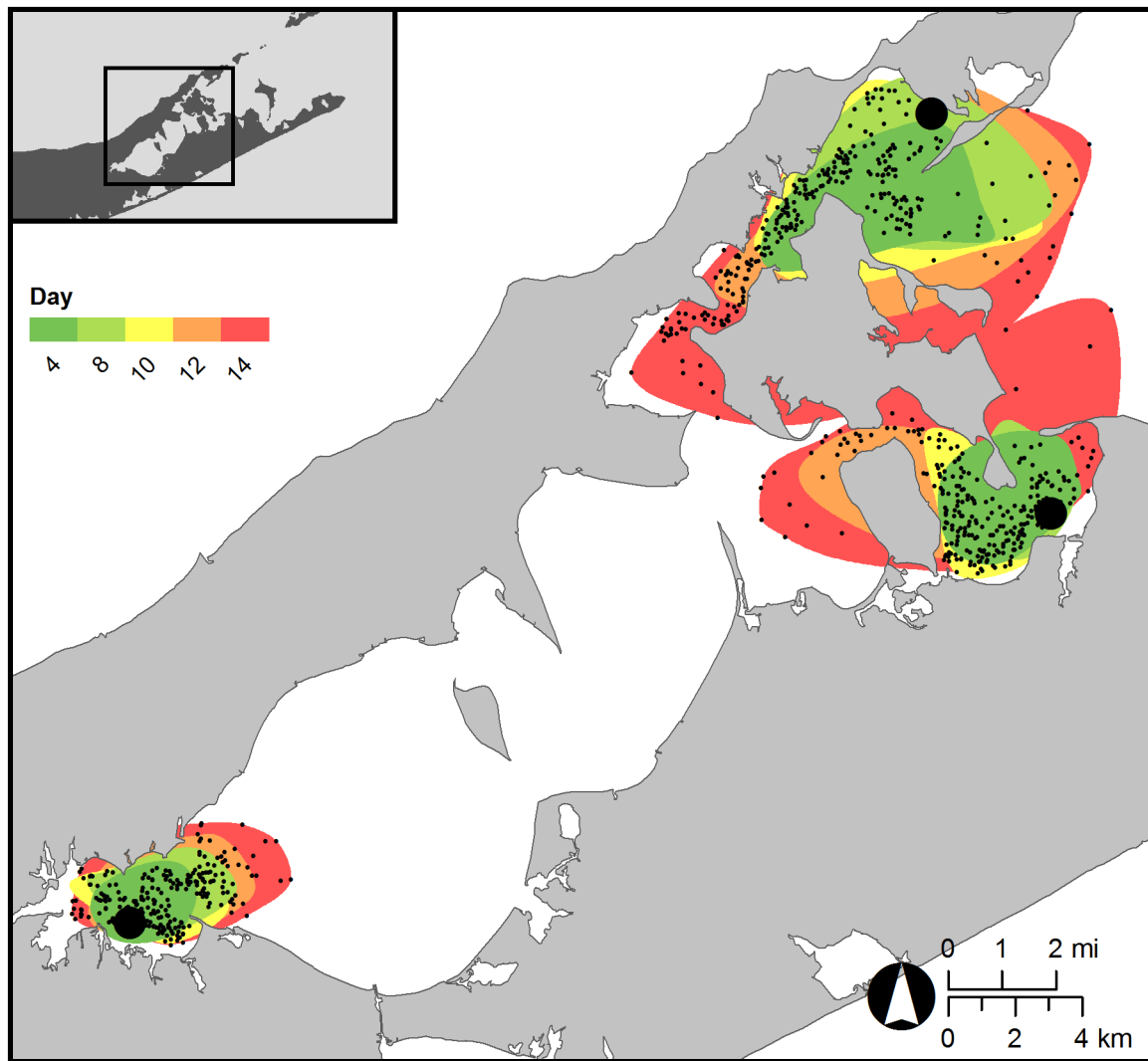


Fig. S1. Composite diagram, adapted from Siddall et al. (1986), showing simulated dispersion of particles (small dots), as a proxy for bay scallop *Argopecten irradians irradians* larvae, from 2.02 ha release points (large black circles) in Flanders Bay, Orient Harbor, and Northwest Harbor (clockwise from left) in the Peconic Bays, eastern Long Island, New York, USA. Colored dispersion polygons represent particle positions at slack water before ebb and/or flood, 4 to 14 d after release at these tidal stages

Supplement 3. Estimation of total fertilized egg production (TFEP)

Computation of TFEP relied on calculation of $F_{i...n}$, the proportion of eggs fertilized at a given density of spawners. Values of $F_{i...n}$ were derived from a polynomial regression equation [$Y = 0.0198 + 2.378(X) - 2.32(X^2) + 0.688(X^3)$, where Y is the mean percentage of eggs fertilized, X is the density (no. spawners m^{-2})] extrapolated from Fig. 7 of Lundquist & Botsford (2004) for a slightly aggregated spawner distribution (many small clumps) and a broad exponential sperm dispersal distribution corresponding to low ($<0.2 m s^{-1}$) current speeds. We assumed these conditions of their model were the best approximation of Peconic Bay field conditions where bay scallops are located. Parameter values, needed to compute TFEP in each of 4 embayments, are given in Table S2.

Table S2. Computation of total fertilized egg production (TFEP) for (a) Orient Harbor (OH), (b) Hallock Bay (HB), (c) Northwest/Sag Harbor (NW), and (d) Southold Bay (SB), for 2005 to 2010, using Eq. (4) (given in text). Spawner density data, from transect surveys in spring (from Tettelbach et al. unpubl. data) are for wild populations at sites given in Table S1, except if denoted as ‘free plant’ or ‘nets’; the latter are planted hatchery-reared scallops. Eggs produced per scallop = 2×10^6 (Belding 1910). nd: no data

A. Calculation of TFEP for Orient Harbor (OH), 2005-2010; outside Long Beach site is excluded because it is beyond OH proper. Area of 4–15 ft (= 1.3–4.6 m) depth stratum for NW = $4.869 \times 10^6 m^2$

Site	Mean spawner density (# per m^2)	Fertilization success rate at this mean density	Proportion of total harbor area represented by site	Total # spawning scallops in embayment represented by site	# eggs produced ($\times 10^9$)	# fertilized eggs produced ($\times 10^9$)
2005						
Greenport	0.055	0.1437	0.1666	44633	89.266	12.82752
Hay Beach	0.04	0.1113	0.1666	32460	64.92	7.225596
East Marion	0.055	0.1437	0.1666	44632	89.264	12.82724
Inside Long Beach	0.035	0.1002	0.1666	28403	56.806	5.691961
Peter's Neck	0.185	0.3847	0.1666	150128	300.256	115.5085
Longlines	0.08	0.1955	0.1666	64920	129.84	25.38372
OH nets	0	0	<0.01	0	0	0
OH free plant	0	0	<0.01	0	0	0
					TFEP	179.4645

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Table S2A (continued)

Site	Mean spawner density (# per m ²)	Fertilization success rate at this mean density	Proportion of total harbor area represented by site	Total # spawning scallops in embayment represented by site	# eggs produced (x 10 ⁹)	# fertilized eggs produced (x 10 ⁹)
2006						
Greenport	nd	nd	nd	nd	nd	nd
Hay Beach	nd	nd	nd	nd	nd	nd
East Marion	nd	nd	nd	nd	nd	nd
Inside Long Beach	nd	nd	nd	nd	nd	nd
Peter's Neck	nd	nd	nd	nd	nd	nd
Longlines	0.007	0.0363	1	34083	68.166	2.474426
OH nets	0	0	<0.01	0	0	0
OH free plant	0	0	<0.01	0	0	0
					TFEP	2.474426
2007						
Greenport	0.047	0.1265	0.1666	38141	76.282	9.649673
Hay Beach	0	0	0.1666	0	0	0
East Marion	0.053	0.1394	0.1666	43010	86.02	11.99119
inside Long Beach	0	0	0.1666	0	0	0
Peter's Neck	0	0	0.1666	0	0	0
Longlines	0	0	0.1666	0	0	0
OH nets	64.3	1	<0.01	90000	180	180
OH free plant	0	0	<0.01	0	0	0
					TFEP	201.6409
	Contribution of planted scallops to TFEP = 52.6%					
2008						
Greenport	0.24	0.4664	0.1666	194760	389.52	181.6721
Hay Beach	0.04	0.1113	0.1666	32460	64.92	7.225596
East Marion	0.327	0.5734	0.1666	265361	530.722	304.316
inside Long Beach	0.36	0.6073	0.1666	292140	584.28	354.8332
Peter's Neck	0.107	0.2485	0.1666	86831	173.662	43.15501
Longlines	0.033	0.0958	0.1666	26780	53.56	5.131048
OH nets	89.3	1	<0.01	251000	502	502
OH free plant	0.5	0.7148	<0.01	150	0.3	0.21444
					TFEP	1398.547
	Contribution of planted scallops to TFEP = 21.8%					

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Table S2A (continued)

Site	Mean spawner density (# per m ²)	Fertilization success rate at this mean density	Proportion of total harbor area represented by site	Total # spawning scallops in embayment represented by site	# eggs produced (x 10 ⁹)	# fertilized eggs produced (x 10 ⁹)
2009						
Greenport	nd	nd	nd	nd	nd	nd
Hay Beach	nd	nd	nd	nd	nd	nd
East Marion	0.1933	0.3978	0.333	313726	627.452	249.6004
Inside Long Beach	0.26	0.4933	0.333	421980	843.96	416.3255
Peter's Neck	0.027	0.0823	0.333	43821	87.642	7.212937
Longlines	nd	nd	nd	nd	nd	nd
OH nets	89.3	1	<0.01	254000	508	508
OH free plant	0.9	0.7824	<0.01	1370	2.74	2.143776
					TFEP	1183.283
Contribution of planted scallops to TFEP = 24.7%						
2010						
Greenport	nd	nd	nd	nd	nd	nd
Hay Beach	0.0533	0.1401	0.25	64879	129.758	18.1791
East Marion	0.9533	0.7744	0.25	1160404	2320.81	1797.234
Inside Long Beach	0.1333	0.2972	0.25	162259	324.518	96.44675
Peter's Neck	0.4933	0.7109	0.25	600469	1200.94	853.7468
Longlines						
OH nets	89.3	1	<0.01	251200	502.4	502.4
OH free plant	0	0	<0.01	0	0	0
					TFEP	3268.006
Contribution of planted scallops to TFEP = 11.2%						

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Table S2 (continued)

B. Calculation of TFEP for Hallock Bay (HB), 2005-2010. Area of 4-15 ft (= 1.3–4.6 m) depth stratum for HB = $1.71339 \times 10^6 \text{ m}^2$

Site	Mean spawner density (# per m^2)	Fertilization success rate at this mean density	Proportion of total harbor area represented by site	Total # spawning scallops in embayment represented by site	# eggs produced ($\times 10^9$)	# fertilized eggs produced ($\times 10^9$)
2005						
Narrow River	0.06	0.1543	0.5	51402	102.804	15.86266
Bulkhead	0.01	0.0433	0.5	8567	17.134	0.741902
Central Flats	nd	nd	nd	nd	nd	nd
HB free plant	0	0	<0.01	0	0	0
					TFEP	16.60456
2006						
Narrow River	0.033	0.0958	0.4915	27790	55.58	5.324564
Bulkhead	nd	nd	nd	nd	nd	nd
Central Flats	0.02	0.0664	0.4915	16843	33.686	2.23675
HB free plant	0.6	0.76	0.017	6560	13.12	9.9712
					TFEP	17.53251
Contribution of planted scallops to TFEP = 56.9%						
2007						
Narrow River	0.033	0.0958	0.25	14135	28.27	2.708266
Bulkhead	0.053	0.1394	0.25	22702	45.404	6.329318
Central Flats	0.04	0.1113	0.25	17134	34.268	3.814028
John's site	0.013	0.0503	0.25	5569	11.138	0.560241
HB free plant	0	0	<0.01	0	0	0
					TFEP	13.41185
2008						
Narrow River	0	0	0.333	0	0	0
Bulkhead	0.047	0.1265	0.333	26816	53.632	6.784448
Central Flats	0	0	0.333	0	0	0
HB free plant	0.8	0.7897	<0.01	626	1.252	0.988704
					TFEP	7.773152
Contribution of planted scallops to TFEP = 12.7%						

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Table S2B (continued)

Site	Mean spawner density (# per m ²)	Fertilization success rate at this mean density	Proportion of total harbor area represented by site	Total # spawning scallops in embayment represented by site	# eggs produced (x 10 ⁹)	# fertilized eggs produced (x 10 ⁹)
2009						
Narrow River	0.0133	0.051	0.333	7588	15.176	0.773976
Bulkhead	0.0667	0.1683	0.333	38056	76.112	12.80965
Central Flats	0.0867	0.209	0.333	49467	98.934	20.67721
HB free plant	18.2	1	<0.01	26440	52.88	52.88
					TFEP	87.14083
Contribution of planted scallops to TFEP = 60.7%						
2010						
Narrow River	nd	nd	nd	nd	nd	nd
Bulkhead	0.04	0.1113	0.5	34268	68.536	7.628057
Central Flats	0.08	0.1955	0.5	68536	137.072	26.79758
HB free plant	27.1	1	0.01	81300	162.6	162.6
					TFEP	197.0256
Contribution of planted scallops to TFEP = 82.5%						

C. Calculation of TFEP for Northwest/Sag Harbor (NW), 2005–2010. Area of 4–15 ft (= 1.3–4.6 m) depth stratum for NW = $7.28198 \times 10^6 \text{ m}^2$

Site	Mean spawner density (# per m ²)	Fertilization success rate at this mean density	Proportion of total harbor area represented by site	Total # spawning scallops in embayment represented by site	# eggs produced (x 10 ⁹)	# fertilized eggs produced (x 10 ⁹)
2005						
Sag Harbor	0.21	0.4232	0.333	509229	1018.46	431.0114
Barcelona	nd	nd	nd	nd	nd	nd
SWG	0.014	0.0526	0.333	33949	67.898	3.571435
Inshore Cedar Pt	0.16	0.3437	0.333	387984	775.968	266.7002
SWG free plant	56.1	1	<0.01	140250	280.5	280.5
SWG nets	214.8	1	<0.01	9880	19.76	19.76
					TFEP	1001.543
Contribution of planted scallops to TFEP = 30%						

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Table S2C (continued)

Site	Mean spawner density (# per m ²)	Fertilization success rate at this mean density	Proportion of total harbor area represented by site	Total # spawning scallops in embayment represented by site	# eggs produced (x 10 ⁹)	# fertilized eggs produced (x 10 ⁹)
2006						
Sag Harbor	0.073	0.1813	0.25	132896	265.792	48.18809
Barcelona	0.007	0.0363	0.25	12743	25.486	0.925142
SWG	0	0	0.25	0	0	0
Inshore Cedar Pt.	0.073	0.1813	0.25	132896	265.792	48.18809
SWG free plant	11.1	1	<0.01	27750	55.5	55.5
SWG nets	203.7	1	<0.01	9370	18.74	18.74
					TFEP	171.5413
Contribution of planted scallops to TFEP = 43.3%						
2007						
Sag Harbor	0.013	0.0503	0.25	23666	47.332	2.3808
Barcelona	0.007	0.0363	0.25	12743	25.486	0.925142
SWG	0.027	0.0823	0.25	49153	98.306	8.090584
Inshore Cedar Pt.	0.033	0.0958	0.25	60076	120.152	11.51056
					TFEP	22.90709
2008						
Sag Harbor	0.007	0.0363	0.25	12743	25.486	0.925142
Barcelona	0.007	0.0363	0.25	12743	25.486	0.925142
SWG	0	0	0.25	0	0	0
Inshore Cedar Pt.	0.013	0.0503	0.25	23666	47.332	2.3808
					TFEP	4.231083

2009						
Sag Harbor	nd	nd	nd	nd	nd	nd
Barcelona	0.0733	0.1819	0.5	266885	533.77	97.09276
SWG	0.1467	0.3209	0.5	534133	1068.27	342.8066
Inshore Cedar Pt.	nd	nd	nd	nd	nd	nd
					TFEP	439.8993
2010						
Sag Harbor	nd	nd	nd	nd	nd	nd
Barcelona	0.4133	0.6549	0.333	1002211	2004.42	1312.696
SWG	0.1267	0.2852	0.333	307235	614.47	175.2468
Inshore Cedar Pt.	1.68	0.7291	0.333	4073831	8147.66	5940.46
					TFEP	7428.403

D. Calculation of TFEP for Southold Bay (SB), 2006–2010. Area of 4-15 ft (= 1.3-4.6 m) depth stratum for SB = $2.31998 \times 10^6 \text{ m}^2$. Here, TFEP equals #fertilized eggs produced ($\times 10^9$; in **bold**)

Year	Mean spawner density (# per m^2)	Fertilization success rate at this mean density	Proportion of total harbor area represented by site	Total # spawning scallops in embayment represented by site	# eggs produced ($\times 10^9$)	# fertilized eggs produced ($\times 10^9$)
2006	0.133	0.2967	1	308557	617.114	183.0977
2007	0.253	0.4841	1	586955	1173.91	568.2898
2008	1.073	0.7502	1	2489339	4978.678	3735.004
2009	0.3533	0.6007	1	819649	1639.298	984.7263
2010	0.3133	0.5583	1	726850	1453.7	811.6007

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