RISA-RWU-RIDEM Quahog Seeding Project

2023 Annual Report

Funded by Rhode Island Department of Environmental Management

Bo Christianson captaining the boat during November 2023 planting (left). Adam McGiveney releasing quahogs in Greenwich Bay during 2023 planting (right). Photos by Susanna Osinski

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2023 Project Summary

This summary was prepared to satisfy the data sharing and reporting requirements of the Quahog Enhancement Program, a joint venture among the RI Shellfisherman's Association (RISA), the RI Department of Environmental Management (DEM), the RI Narragansett Bay Commission (NBC), and Roger Williams University (RWU). Appendix A consists of the Scope of Work for the project taken from the current MOU (2021–2026).

On July 13, 2023, quahog seed (125,000 @ R6) were picked up from the Aquaculture Research Cooperation (ARC) hatchery in Dennis, MA and brought to RWU where they were graded by size and kept in coolers on ice overnight before being distributed the next day at the RISA upweller at Safe Harbor Greenwich Bay Marina, Warwick, Rhode Island.

Two Onset HOBO temperature loggers were attached at the inflow and outflow of the system for water temperature recording. Over the next four months, RISA members weekly maintained, fixed, and cleaned the upweller while RWU staff would come about every four weeks to wet sieve and collect measurements, volume counts, and environmental parameter data. On October 26, 2023, a final count, wet sieve, and measurements were recorded before RISA volunteers and the RWU Shellfish Field Operations Manager planted the seed into Greenwich Bay around the Potowomut Spawner Sanctuary Area B - Tagging Area 8E on November 9, 2023.

Volume and Mortality

July's quahog seed drop-off to RISA started with 30.5 total liters. By November's planting, the seed totaled 192.3 liters. Each month, volume measurements were taken counting live and dead totals in 100 mL samples, replicated up to five times per size category to get an approximate total count. The <8-mm category tended to have the highest amount of mortality in August and September (**Table 1**). However, there was a noticeable increase in mortality around October in the 11-15 mm and >15-mm categories. We estimated a total mortality of 9,300 individuals (1.3%) from the purchased amount of 125,000 quahogs. Overall, a mortality rate of less than 5% encourages us that the production system is working well. The August 10 sampling did have a 6-mm wet sieve accidentally used in place of an 8-mm sieve, so the values for <8mm and >8mm are slightly misleading.

Table 1. Total volume (liters) of live and dead from each wet sieved size category. Dashes notate where size classes were not applicable. **Bolded** values represent size category with greatest volume for each sample date of live quahogs. Dead volume was back calculated from subset volume counts.

	Sample Dates									
Size Category	***July 14*** *(L)*		***Aug 10*** *(L)*		***August 31*** *(L)*		***September 28*** *(L)*		***October 26*** *(L)*	
	Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead
<6-mm	7.35	0.15	-	-	-	-	-	-	-	-
>6-mm	**22.95**	0.05	-	-	-	-	-	-	-	-
< 8-mm	-	-	2.30	0.20	7.96	0.54	2.16	0.34	1.70	0.30
8-11 mm (>8-mm)	-	-	**60.6**	0.40	**70.0**	0	26.95	0.05	17.5	0
11-15 mm	-	-	0.10	0	26.99	0.01	**86.0**	0	47.4	0.40
>15-mm	-	-	-	-	0.15	0	54.98	0.02	**124.6**	0.40
TOTAL VOLUME	30.5		63.6		105.65		170.5		192.3	

Measurements and Growth Rates

Over the course of the season, length and height were measured for each size category (n = 25; **Figure 1**, **Table 2**). The smallest size measurements came from the initial upweller drop-off measurements (July), with an average length of 8.33 ± 1.19 mm and height of 7.51 ± 1.06 mm. The largest size measurements (September) were a length of 14.42 ± 3.69 mm and a height of 12.58 ± 3.07 mm.

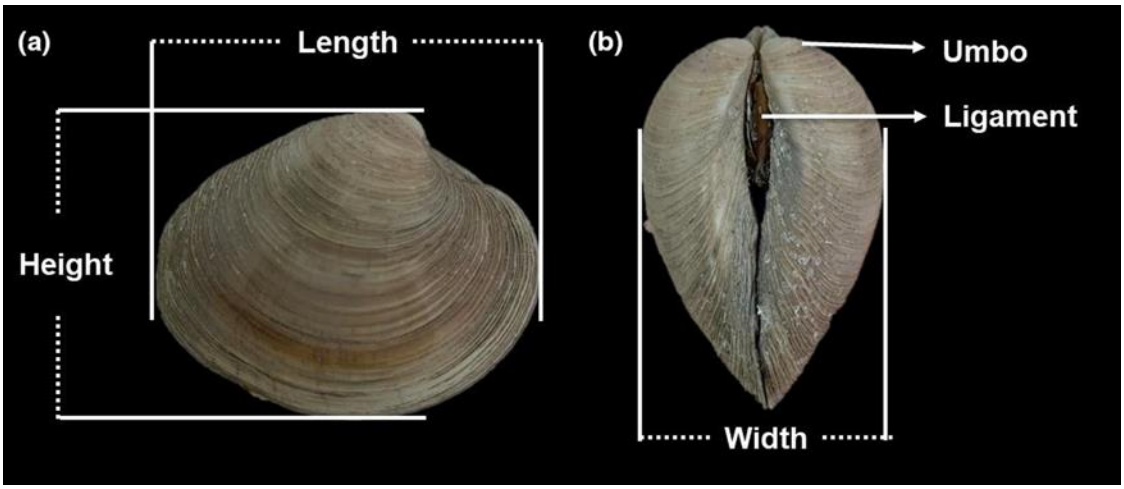

Figure 1. Photos of quahog (*Mercenaria mercenaria*) defining (a) shell height, length, and (b) width. From Zeng & Wang 2020. https://doi.org/10.1111/are.14866.

Table 2. Average (mean) quahog length (L) and height (H) ± standard deviation for each sieve size class from each sample date, as well as combined average from all categories from each date. Replicates in parentheses (*n*) multiplied by the number of sieve size classes measured during the sample date. Dashes notate where size classes were not applicable.

	Sample Dates									
Size Category	***July 14* (*n* = 25 × 2)**		***August 10* (*n* = 25 × 2)**		***August 31* (*n* = 25 × 4)**		***September 28* (*n* = 25 × 4)**		***October 26* (*n* = 25 × 4)**	
	L (mm)	*H (mm)*	*L (mm)*	*H (mm)*	*L (mm)*	*H (mm)*	*L (mm)*	*H (mm)*	*L(mm)*	*H (mm)*
<6-mm	7.39 ± 0.82	6.70 ± 0.77	-	-	-	-	-	-	-	-
>6-mm	9.27 ± 0.63	8.32 ± 0.57	-	-	-	-	-	-	-	-
< 8-mm	-	-	8.61 ± 1.21	7.66 ± 1.04	10.45 ± 1.59	9.22 ± 1.40	9.26 ± 1.86	8.17 ± 1.56	8.60 ± 1.16	7.78 ± 1.31
8-11 mm (>8-mm)	-	-	11.77 ± 1.42	10.37 ± 1.15	13.45 ± 0.69	11.90 ± 0.64	13.73 ± 0.82	12.20 ± 0.71	13.41 ± 0.76	11.87 ± 1.07
11-15 mm	-	-	-	-	15.17 ± 0.65	13.27 ± 0.51	15.96 ± 1.06	13.98 ± 0.88	15.67 ± 0.88	13.99 ± 0.75
>15-mm	-	-	-	-	17.15 ± 0.61	15.18 ± 0.62	18.74 ± 0.85	15.95 ± 0.92	18.06 ± 1.26	16.18 ± 1.04
Combined	8.33 ± 1.19	7.51 ± 1.06	10.19 ± 2.06	9.02 ± 1.74	14.06 ± 2.66	12.40 ± 2.36	14.42 ± 3.69	12.58 ± 3.07	13.92 ± 3.66	12.45 ± 3.29

Measurements from all size classes were combined and averaged for each sample date to determine the change in growth between sample visits. As seen in **Table 3**, the largest change occurred from August 10 to August 31 while the smallest change in growth occurred from September 28 to October. This reduction in growth, or lack thereof, may be attributed to overcrowding and/or seasonal change as well as randomness while measuring. Overall, the combined change in growth throughout the season was approximately 5.59 mm in length and 4.94 mm in height (**Table 3**).

Table 3. Average change in growth (length and height) for all quahog size categories between sample dates. **Bolded** row notates the month with the greatest change in growth.

Sample Dates	Change in Growth Between Dates	
	Length (mm)	*Height (mm)*
July 14 – August 10 (27 days)	1.22	1.20
August 10 – August 31 (21 days)	**3.87**	**3.38**
August 31 – September 28 (28 days)	0.36	0.18
September 28 – October 26 (28 days)	-0.50	-0.13

Environmental parameters

Dissolved oxygen (%) and salinity (ppt) were some of the environmental variables collected via YSI instrumentation at each sample date. From July to November, dissolved oxygen somewhat varied between 74.4% and 105.7% while salinity varied very little between 25.1 ppt and 26.5 ppt (**Figure 2**). Some of the variation seen around September could be attributed to the tropical storms that came through the area.

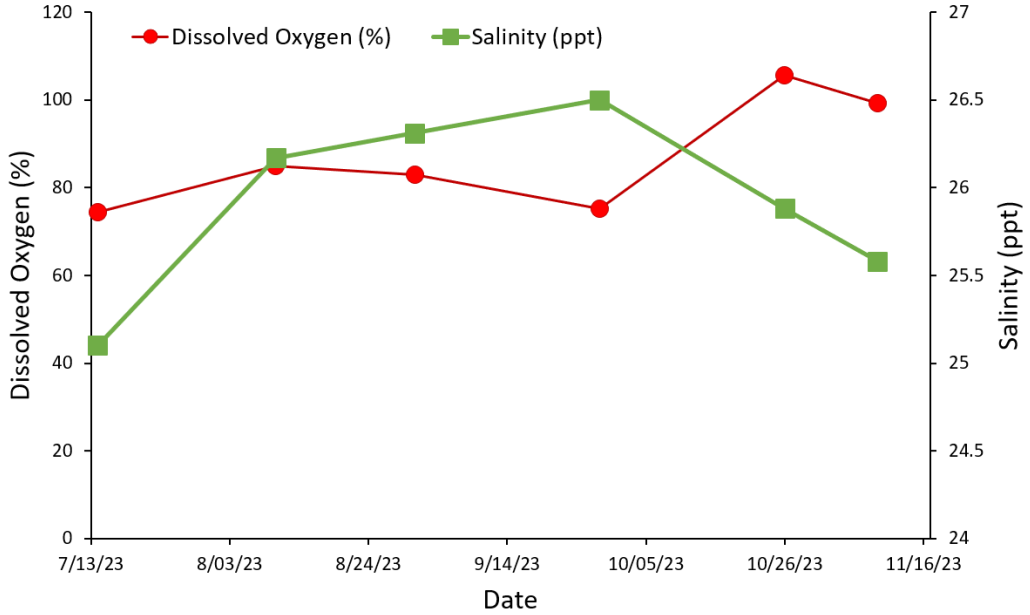

Figure 2. Measurements of salinity (ppt) and dissolved oxygen (%) from July drop-off to October on each sampling date.

Water temperature was recorded via two HOBO loggers submerged at opposite sides of the upweller tank set to record every hour and averaged together for each day. Starting in July, there was an overall downward trend (**Table 4**), with exception to the heat waves that occurred mid-September (**Figure 3b**). The tanks' average daily water temperature started at 82.33 °F (27.96 °C) in July and eventually fell to a cool 51.99 °F (11.11 °C) by planting day (**Figure 3b**).

Table 4. Monthly average water temperature (°F) in upweller (July recording started on July 14 at the drop-off).

Month	**July**	**August**	**September**	**October**	**November**
Average Temperature (°F)	82.6	76.4	73.2	63.3	54.3

The average length and height are shown in **Figure 3a** in combination with average daily water temperature of the tank (**Figure 3b**). There was a noticeable increase in size showing large growth seen in both length and height, starting early August through early September while water temperatures were still well above 70 °F (21.11 °C; **Table 3, Figure 3**). Average size then seemed to plateau as September began when water temperatures started to drop below 70 °F. However, total volume continued to increase well until the end of September and even into October showing that the faster-growing quahogs tended to hit their maximum size around September while the smaller ones used that time to catch up on growth before planting (**Table 1, Figure 3**).

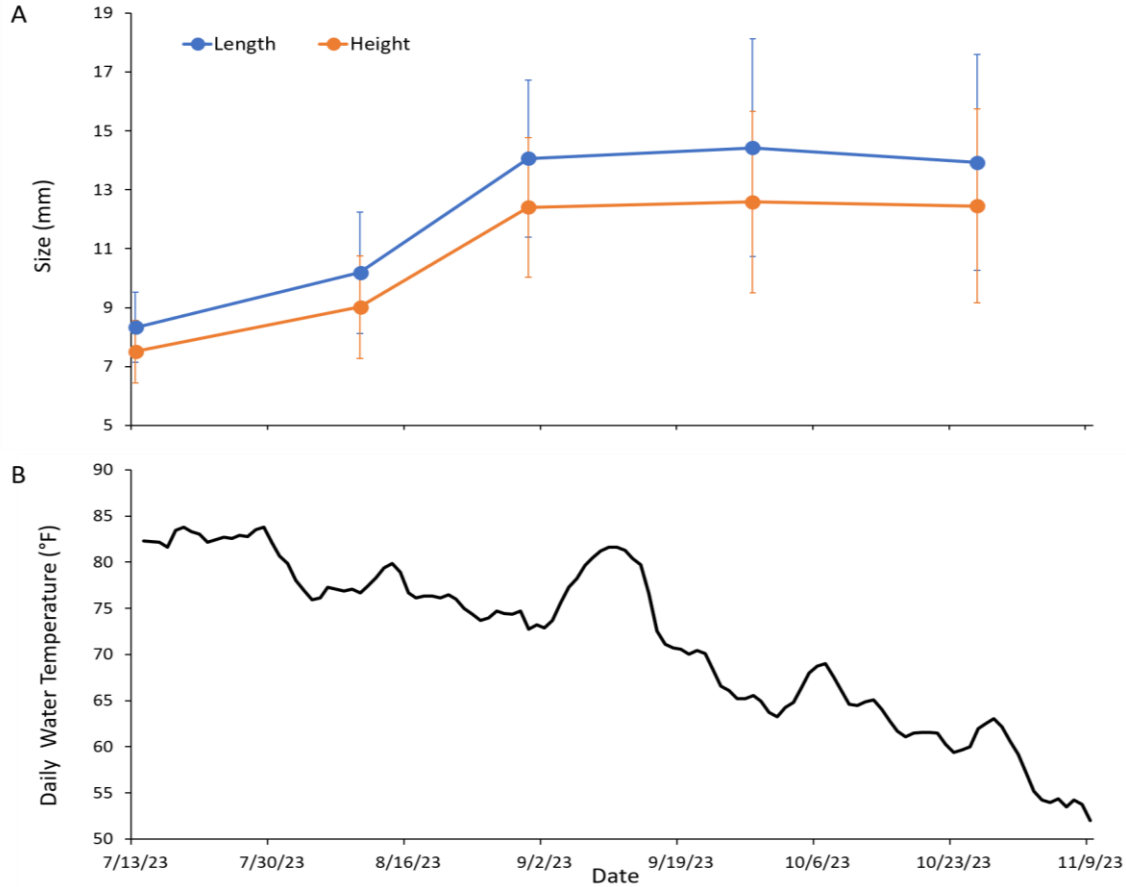

Figure 3. (a**)** Average (mean) ± standard deviation of length (blue) and height (orange) and (b) averaged daily water temperature (°F) recorded from upweller tank. Quahogs measured on July 13 (*n* = 50), August 8 (*n* = 50), August 31 (*n* = 100), September 28 (*n* = 100), and October 26 (*n* = 100), 2023.

Quahog Planting

Table 5. GPS coordinates and water temperature (°F) of Greenwich Bay, Area 8C/8E, where quahogs were planted on November 9, 2023.

Latitude	Longitude	Water Temperature
N 41°66'76.9"	W -71°40'22"	52.16 °F

Comparison to Past Data

- **2020** - Ordered 50,000 quahogs, final count = ~40,000–45,000 quahogs.
  - At seeding, 41.2% in 10–15 mm length category **(Table 6)**
  - Start volume: *unknown*, End volume: 139 liters
- **2021** - Ordered 100,000 quahogs, final count = ~90,000–95,000 quahogs.
  - At seeding, 66.6% in 15–20 mm size category **(Table 6)**
  - Start Volume: *unknown*, End volume: 142 liters
- **2022** - Ordered 125,000 quahogs, final count = ~120,000 quahogs.
  - At seeding, 86.03% in 10–15 mm length category **(Table 6)**
  - Start volume: 35.9 liters, End volume: 134 liters
- **2023** - Ordered 125,000 quahogs, final count= ~115,000–120,000 quahogs.
  - At seeding, 62.9% in 15–20 mm size category **(Table 6)**
  - Start volume: 30.5 liters, End volume: 200 liters

Table 6. A comparison of quahog seed planted in 2020, 2021, 2022, and 2023 by length category by count (individuals) and percentage of seed planted. Size classes that contributed the largest percentage to the planted seed are **bolded**.

Year	**2020**		**2021**		**2022**		**2023**	
Length Size Class	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
<10 mm	0	0	18,693	18.3	0	0	12,535	10.2
10 - 15 mm	23,950	**41.2**	15,361	15.1	107,160	**86.03**	28,635	23.3
15 - 20 mm	17,826	30.7	67,945	**66.6**	17,395	13.97	77,420	**62.9**
20 - 25 mm	16,360	28.1	0	0	0	0	4,580	3.7

Discussion, Suggested Improvements, and Potential Research Directions

The 2023 season used the same quantity and size seed (125,000 @ R6) as 2022. On July drop-off, a new sump pump was purchased and installed due to the old pump not working. Lumber and fasteners were also purchased to rebuild the support frame from the pontoons to the tank as the old frame had started to give in. Silo mesh sizes were increased incrementally throughout the season, even by initially starting the quahogs between 13 silos instead of the usual six to eight, and eventually maxing out into all 24 silos of varying sizes (2, 4, 6, and 9-mm) by September. Multiple 9-mm mesh box bags and cylinders were added in early October to minimize overcrowding and intraspecific competition from the very full silos in efforts to increase available flow and food opportunity until planting, as increased die-off was seen in the larger quahogs at the time.

Larger-sized mesh silos (6-mm and 9-mm) were also made this year allowing quahogs to move up to the bigger mesh, and sooner. Silos also gained a new silicone caulk seal along the bottom where the mesh and silo meet to further prevent fallout and loss which looked pretty successful. Mesh covers were also made for silo PVC pipes to prevent loss through the outflow. The upweller tank itself was power-washed during monthly visits as well. RISA will try to do more general draindowns during weekly rinsing, and powerwash more often, as it helped a lot with biofouling control, especially with the sea squirts that are always a problem at the Warwick upweller. Wet sieving methods, field data sheets, and data collection were more consistent than previous years, fulfilling some of the goals from last year. We believe the combination of improvements this year allowed for a much larger number of quahogs to reach bigger and more ideal planting sizes faster, with more consistent overall growth as seen in the almost 200 liters planted this year.

Due to faculty/staff changes at RWU, our Luther H. Blount Hatchery has been unable to produce the required quahogs for this project for the past few years, so seed had been purchased from ARC which has depleted much of the remaining budget. For 2024, RWU's new Shellfish Aquaculture and Hatchery Specialist, Dr. Robert Holmberg, is planning to produce the needed quahog seed at a lower cost. Due to ongoing hatchery renovations, it is proposed to move the seed to the RISA Warwick upweller earlier in the year, aiming for the end of May 2024 should RWU Staff and RISA members be able to coordinate the proper caring schedule. The starting count will also be reduced from 125,000 to a goal of 100,000 quahogs in order to once again maximize growth and reduce potential overcrowding, as well as reduce the demand on the RWU Luther H. Blount Hatchery in their newly updated setup.

RISA plans to make more new silos with different mesh sizes as many older silos are losing structural integrity. The old pump was given to RWU in hopes it can be fixed and become a back-up. The consistency in data sampling and collection was beneficial for more accurate reporting and will be continued. The 8-mm and 15-mm diamond wet sieves will also be changed to a 9-mm and 14-mm square mesh for less variation in size groups.

Statement of Work & Acknowledgements

RI DEM provides funding for this work at $2000 per fiscal year over five years (2021–2026). In 2020, Narragansett Bay Commission also made a ~$11,000 donation to the project which has helped fund repairs, seed purchase, and temperature loggers. RWU Staff Kelly Meyer, and Faculty Dr. Timothy Scott, helped coordinate the budget and reimbursements to RISA for their purchases on the project this year. Quahog seed was grown by Aquaculture Research Center (ARC)'s hatchery on Cape Cod. Susanna Osinski was the lead coordinator of the RISA project in 2023, organizing communications between staff, students, RISA members, and timelines. Susanna also updated standard operating procedures (SOPs), led measuring, sorting, planting, data collection and analysis, as well as the report writing. Kristen Savastano led student training as well as assisted with measuring, cleaning, and sorting on sampling dates. Kristen also assisted in SOP updates, data entry, analysis, and the report figure development and writing. Dr. Hisham Abdelrahman joined the RWU Shellfish Program as our new Aquaculture Extension Specialist and Assistant Professor of Marine Biology at the end of August and will take over as RWU's Principal Investigator for this project going further. Dr. Abdelrahman edited and revised this report. RWU summer interns, Reagan Williams and Connor Huntley, were both integral help throughout the height of the summer season, assisting staff with drop-off, data collection, measurements, sorting, cleaning, and data entry. Thank you to all RISA members who dedicated their time, and effort, to cleaning and caring for the quahogs during these summer months. Thank you as well to Adam McGiveney for lending his boat during planting as well to Bo Christianson and Rich Lonks for their help on planting day. Special thanks to Mike McGiveney, president of RISA, who not only helped during planting, but also coordinated with RISA members for weekly maintenance and has made sure this meaningful project continues every year.

From left: Mike McGiveney, Rich Lonks, and Adam McGiveney planting clams in Greenwich Bay, November 2023. Clams from October 2023 sample date with large noticeable growth rings (right). Photos by Susanna Osinski.

Appendix A: Memorandum of Understanding RWU-RI-DEM: Scope of Work

The following is a copy of the Scope of Work section in the Memorandum of Understanding between RI DEM, RWU, and RISA for the duration project (2021–2026)

Collaboration and assistance shall be carried out through any one or more of the following activities toward completing the goals of improved shellfish restoration and harvest opportunities.

RWU will annually provide seed for the RISA upweller, located in Warwick, Rhode Island. Seed quantity and total costs will be confirmed between RWU, DEM DMF, and RISA annually prior to final purchase to ensure all parties are able to carry out the year's work. In collaboration with RISA, RWU will monitor seed growth for determining the proper time for seed to be relocated to the wild. RWU and RISA will coordinate with DEM DMF on the timing of seed release and confirm the locations for seeding, which must be agreed upon by all parties. This research will include data collection from the shellfish restoration work, most of which pertains to population structure and contribution to harvestable wild stock. Data streams to be collected by RWU include, but are not limited to:

- Date, total number, and size composition seed brought to the upweller in Warwick.
- Growth rates of seed calculated from size of seed measured when brought to upweller, once per 4-6 weeks thereafter, and within one week of seeding.
- Temperature measurements accompanying dates when growth rates are measured and/or the insertion of a temperature logger in the upweller from when seed is brought to the upweller until seeding.
- Date, estimated number and size composition of the seed from the upweller prior that is released, and similar estimates when seed are checked periodically at the upweller prior to release.
- Location(s) of where seed is planted (GPS coordinates); Temperature of water at location and time of planting.
    - Must notify the DEM Division of Law Enforcement prior to seed planting.

Data will be reported from RWU to DEM DMF annually on the seeding events. A report describing the activities, and associated data files will be provided to DEM DMF for use in the state's shellfish science and management goals. Further, regular updates on project progress is expected in the event issues arise and require amendments to the research goals. In the event eligible funds for seed are not utilized, apportioned available funds may be used for additional research activities that relate to the goals of the project, only after consulting with the DEM DMF.

The terms of such activities, publication credits and budgets, and funding required for any such project shall be mutually discussed and agreed upon in writing and signed by all Parties prior to the initiation of any specific program or activity. Any such program or activity shall be negotiated on a periodic basis as agreed upon by the Parties. Each Party will designate a project leader to assume the responsibility of implementation and coordination of shared activities and programs. The Parties shall cooperate and agree upon any publicity associated with the terms of, and activities provided for, under this Memorandum.