Water Resources Outreach Education Program

2022 Research & Education Vessel Use Report

Water Resources Outreach Education Program

2022 Research & Education Vessel Use Report

Prepared by
Christina Catanese, Education Specialist

Robert B. Annis Water Resources Institute
Grand Valley State University

Table of Contents

Executive Summary 1

Program Overview 2

2022 Season Highlights 3

- Research 3
- Outreach & Education 5
  - COVID-19 Response 9
  - *W.G. Jackson* Away Trips 10
  - Outreach Program based in the R.B. Annis Educational Foundation Classroom 10
  - Support Materials 13
    - Table 1. History of Participants Aboard the *W.G. Jackson* 14
    - Table 2. History of Participants Aboard the *D.J. Angus* 15
    - Table 3. History of Participants Aboard both vessels 16
    - Figure 1. Number of Participants Each Year by Age Group 18
    - Figure 2. Percentage of Groups by Age Aboard AWRI vessels 20
    - Table 4. Number of Groups listed by Michigan County Aboard AWRI Vessels 21
    - Figure 3. Percentage of Trips by Michigan County Aboard AWRI vessels 22
    - Figure 4. Map of the Historic Reach of the Vessel Program 24
    - Table 5. Number of groups and individuals by age group using the R.B. Annis Foundation Educational Classroom 25
    - Figure 5. Percentage of R.B. Annis Foundation Educational Classroom use by age group 25
    - Table 6. Number of groups by county using the R.B. Annis Educational Foundation classroom 25

2023 Outlook and Goals 26

- Opportunities 26
- Challenges 27
- Program Goals 29

Appendices 30

- AWRI Publications Related to Use of AWRI research vessels 30
- Vessel Program Staff 33
- Groups using the *W.G. Jackson* in 2022 35
- Groups using the *D.J. Angus* in 2022 36
- Detailed Listing of Outreach and Education Events during the 2022 Season 37
- Evaluation Data 48

Executive Summary

The Water Resources Outreach Education Program, housed in the Robert B. Annis Water Resources Institute (AWRI), delivers hands-on, investigative education about water to the public, with special emphasis on youth. Our ship-based learning laboratories connect people in west Michigan with local water resources through experiential learning about water quality, aquatic food webs, and human impacts on water resources. The outreach program is integral to AWRI, a multidisciplinary research organization within GVSU's College of Liberal Arts and Sciences, with a mission to integrate research, education, and outreach to enhance and preserve freshwater resources.

Participants aboard an educational cruise serve as freshwater scientists, collecting data and observations about the water bodies through which they sail. Since 1986, over 188,000 students (fourth grade through adults) have experienced hands-on science on Lake Michigan and adjoining waters through these programs, including over 18,000 GVSU students and staff. Offered onboard GVSU's research and education vessels *D.J. Angus* (docked in Grand Haven) and *W.G. Jackson* (docked in Muskegon), the program serves school groups as well as other organizations. Both vessels are used for AWRI research projects as well as the outreach program.

In 2022, over 3000 visitors from 71 schools experienced aquatic science onboard the *W.G. Jackson* and *D.J. Angus.* Public, private, charter, home schools, and parochial schools are all regular users of the vessels. Participants in outreach and education activities on the vessels in 2022 included: 640 elementary school students (20.1%); 1300 middle school students (40.1%); 264 high school students (8.3%); 301 GVSU students (9.5%); and 649 adults including teachers, chaperones, other college students, groups, and the general public (20.4%). Program participants visited AWRI from Kent (62 trips), Ottawa (38), Muskegon (29), Kalamazoo (5), Ingham (4), Calhoun (3), Allegan (2), Ionia (2), and Newago counties (1), plus one international group.

The 2022 season continued to be impacted by the COVID-19 pandemic in several ways, though significantly less so than the 2021 season. Registration on both vessels in 2022 approached but was still lower than pre-pandemic levels. However, participation levels on the vessels were more than three times higher than the 2021 season (Fall only), indicating that we are moving in the right direction and registration will continue to trend toward pre-pandemic levels.
The health and safety of visitors, staff, and students continued to be our highest priority. The AWRI vessel staff developed protocols based on current state, local, GVSU, Coast Guard, and Centers for Disease Control (CDC) requirements and guidelines, though all of the guidelines shifted throughout the year.

Going into the 2023 season, the AWRI vessel program is well-positioned to build on past successes and grow the program into the future. Many opportunities exist for the program to evolve to meet the needs of today’s learners and incorporate the most pressing science into the vessel curriculum. Challenges (internal and external) also exist that pose threats to realizing this potential.

AWRI vessel instructor Doug Haywick explains Spring Lake water quality to students onboard the D.J. Angus. Photo Credit: School News Network/Dianne Carroll Burdick

Program Overview

The Robert B. Annis Water Resources Institute (AWRI) is a multidisciplinary research organization within GVSU's College of Liberal Arts and Sciences, with a mission to integrate research, education, and outreach to enhance and preserve freshwater resources. The Water Resources Outreach Education Program delivers hands-on, investigative education about water to the public, with special emphasis on youth. Our ship-based learning laboratories connect people in west Michigan with local water resources through experiential learning about water quality, aquatic food webs, and human impacts on water resources. Participants aboard an educational cruise serve as freshwater scientists, collecting data and observations about the water bodies through which they sail. Since 1986, thousands of students (fourth grade through adults) have experienced hands-on science on Lake Michigan and adjoining waters through these programs. Offered onboard GVSU's research and education vessels *D.J. Angus* (docked in Grand Haven) and *W.G. Jackson* (docked in Muskegon), the program serves school groups as well as other organizations.

In 1965, entrepreneur Donald J. Angus generously donated his personal vessel, the *Angus,* to Grand Valley State College. For nearly 20 years, the *Angus* served as a floating classroom and laboratory. In 1986, a new research vessel, the *D. J. Angus,* replaced the *Angus,* and the AWRI Water Resources Outreach Education Program was established. The success of the onboard programs led to the *Making Waves in Muskegon* campaign, with a goal to raise funds to build and endow a second vessel, the *W.G. Jackson*, named after Dr. William Jackson, which began operating in July 1996. With the addition of the *W.G. Jackson*, the AWRI has been able to serve an even greater number of individuals through our onboard programs, as well as enhance AWRI research. Notably, the *W.G. Jackson* can accommodate more individuals than the *D. J. Angus*, due to the larger size of the *W.G. Jackson* and U.S. Coast Guard safety regulations.

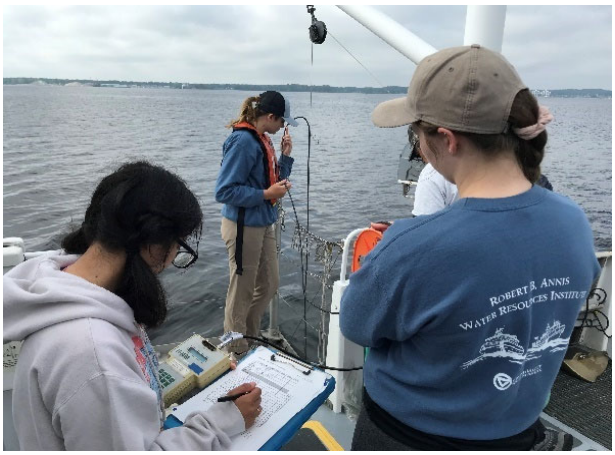
To date, there have been over 188,000 participants in the years of the program. They include: elementary school students (21%); middle school students (27%); high school students (10%); GVSU students (10%); adults including teachers, chaperones, other college students, groups, and the general public (23%); and dockside events (10%). Both vessels are used for AWRI research projects as well as the outreach program.

The onboard curriculum is structured around conducting water quality tests and other observations to compare the physical, biological, and chemical characteristics of Lake Michigan to smaller inland lakes. Both vessels offer the same overall trip structure and curriculum with place-based variations appropriate to their settings. For example, the *W.G. Jackson* trips discuss the industrial history and recent restoration of Muskegon Lake and its watershed, and how these inform today's water quality. In contrast, the *D.J. Angus* cruises focus on the influence of the Grand River watershed and the status of smaller, shallower Spring Lake.

Samples of plankton, benthic organisms, and bottom sediments collected from Lake Michigan (front) and Spring Lake.

2022 Season Highlights

Research



AWRI students and interns take water samples during a 2022 Muskegon Lake monitoring trip.

The AWRI vessels have played an integral role in a range of research projects. For example, very little is known about the fungi that are found at the bottom of freshwater habitats. But two recent publications (Anderson. et al. 2022, Wahl et al. 2018) on Great Lakes fungi have started to fill some knowledge gaps. The publications are products of a four-year study that was possible only with the support of AWRI vessels. Both the *W.G. Jackson* and *D.J. Angus* were employed to collect sediment from the bottom of Lake Michigan as part of a project funded by the National Institute of Health to study Great Lakes fungal communities. Using the AWRI vessels, Dr. Mark Luttenton collected nearly 200 sediment samples, some from as deep as 910 feet. Collaborators at three partner institutions have isolated and identified a wide array of fungi from Great Lakes sediments, and the fungi are being screened for chemicals that may destroy a range of cancer cell types, particularly pediatric cancers. The results so far have been extremely encouraging, with extracts from several fungal isolates exhibiting extremely high anticancer activity.

The *W.G. Jackson* was also used in a recent research project on microplastics in Muskegon Lake. After incubating known quantities of different types of plastics for several months in the lake, microplastics were retrieved and examined for chemical and biological impacts. The *W.G. Jackson* was used to deploy

and retrieve the microplastic incubations several years ago; one paper was recently published using the data collected (Scott et al. 2021), and others are in development.

The W.G. Jackson Vessel Support Fund (held at the Community Foundation for Muskegon County) supports ship time on the *W.G. Jackson* for long-term monitoring of Muskegon Lake (see Appendix: Steinman and Ogdahl 2004). AWRI's monitoring of Muskegon Lake began in summer 2003. AWRI technicians collect samples at six stations to establish baseline water quality conditions. Stations were chosen to represent varying conditions across the lake. These stations are sampled 3 times per year (late spring, summer, early fall) from the *W.G. Jackson*. Fish monitoring is done at 4 other shallow-water sites using smaller vessels. Scientific papers based on data collected from the long-term monitoring study have been published in a variety of journals (see Appendix). These data sets have been incorporated in Master of Science theses as well. The Muskegon Lake Water Quality Dashboard provides an easy to understand visual representation of lake health. Sampling events in May, July, and September took place as usual in 2022.

The *W.G. Jackson* frequently also supports research in conjunction with the Muskegon Lake Observatory buoy, which is run by Dr. Bopi Biddanda's laboratory. A stop at the buoy is a highlight of K-12 and public cruises in Muskegon Lake. A lesson using the Muskegon Lake Observatory data has been developed for teachers (Vail et al. 2015).

Outreach & Education

Trips for the 2022 season on the *D.J. Angus* ran from April 18 through October 21. The *W.G. Jackson* season ran from May 9 through October 21, with a delayed start due to the closure of the lift bridge in Grand Haven. This was the first full year of trips since 2019 due to the COVID-19 pandemic, since all education and outreach programs were cancelled for Spring and Fall 2020 and Spring 2021.

Students conduct dissolved oxygen tests in the lab on the D.J. Angus. Photo Credit: School News Network/Dianne Carroll Burdick

In 2022, there were no trip cancellations due to inclement weather, though several trips made weather-related adaptations (for example, not sailing on Lake Michigan in high wave and wind conditions). Two boat-related issues on the *W.G. Jackson* resulted in programing modifications: One trip was conducted at dockside due to an engine failure, and the final trip of the season was cancelled due to a failed oil seal on the generator.

Thanks to the support from the community, various grants, and the R.B Annis Foundation, our endowment-generated income significantly reduces the cost of each trip, leaving groups to cover only a small registration fee and transportation costs. Interest earnings from our vessel endowment supports trips onboard both vessels for schools and other groups, and ensures well-trained captains, deckhands, and science instructors are onboard for outreach and education cruises (see Appendix for the staff listing). Without doubt, fewer classes or groups would be able to take part in this unique program without this subsidy. Some groups have paid the full price for a trip when there are no more endowment-supported trips available.

Students assist Deckhand Tim Halloran with collecting water samples of Muskegon Lake on the W.G. Jackson

Registration on both vessels in 2022 approached but was still lower than pre-pandemic levels. A total of 3,180 people on 153 trips participated in vessel programming in 2022, compared to 5,231 people on 251 trips in 2019 (Table 3). However, participation on the vessels was more than three times higher than the 2021 season (which was half as long with trips running in the fall only), indicating that we are moving in the right direction and registration will continue to trend toward pre-pandemic levels.

In 2022, middle school trips (6-8 grade) continued to account for the largest proportion of vessel program participants: 46% on both vessels; 36.5% on the *D.J. Angus* and 52.8% on

the *W.G. Jackson* (Figure 2). This is consistent with use trends on the vessels since the early 2000s (Figure 1). Of the under 12th grade set, high school students and elementary school students used the vessels in comparatively smaller numbers. Public, private, charter, home schools, and parochial schools are all regular users of the vessel.

Most students participate in the vessel program through a class field trip; however, some students participate through out-of-school time programs and summer camps. This year, we had one returning (Mt. Zion Church) and two new (STEM Greenhouse and Jack & Jill Grand Rapids chapter) summer camps which specifically serve students of color, who are historically underserved by science education. In the future, more partnerships with informal learning programs, such as these, have great potential to reach additional students when school resources are stretched.

Over 18,000 GVSU students and staff have been on both vessels since 1986. The *D. J. Angus* continues to be the main vessel that serves GVSU students and staff. GVSU courses accounted for a higher proportion of trips on the *D.J. Angus* (21.4%) versus the *W.G. Jackson* (5.6%), which is consistent with past years**.** Most of the GVSU class use is in September and October, and the vessel experience has long been a part of the curriculum for some GVSU courses. The GVSU courses using the vessel in 2022 were: Biology 107 (Great Lakes and Other Water Resources), Biology 362 (Biology and Diversity of Fishes), Education 631 (Teaching Science K-8), HNR151-152 - Making Waves, Geology 105 and 430, and Public Health 520 (Public Health Program Evaluation). GVSU's ExCEL summer camp also utilized the Angus. In 2022, courses from Muskegon Community College, Calvin University, and the Baker College of Nursing also participated in cruises on the vessels.

For adult visitors: the Muskegon Lakeshore Chamber of Commerce again brought its Muskegon In Focus program on the *W.G. Jackson*, a leadership development program for local professionals. The African Center for Aquatic Research and Education (ACARE)'s African Women in Science group from the African Great Lakes took a trip on the *W.G. Jackson* while in town for the Joint Aquatic Sciences meeting (JASM) in May 2022, which received significant media coverage. AWRI Director Al Steinman also hosted a cruise for JASM attendees as part of the event's field trip offerings. The Nelson Neighborhood Improvement Association (Muskegon) also took a trip with neighborhood families. Last and notably, Steinman hosted Senator Gary Peters on the *W.G. Jackson* for a tour of Muskegon Lake.

ACARE's African Women in Science group from the African Great Lakes taking a trip on the Jackson while in town for the JASM in May 2022

The service areas differ somewhat between the two vessels, likely due to ease of geographic access (Figure 4). In 2022, Kent County accounted for the largest number of trips on the *W.G. Jackson* (48.8%), whereas the *D.J. Angus* saw the largest number of trips originate from Ottawa County (40.6%), where it is berthed. Most but not all trips from Muskegon-based groups made their trips on the *W.G. Jackson* (24.4% of total). A smaller number of groups from farther away counties again made trips on both boats this year (Figure 3).

Throughout the years, there have been groups from 27 Michigan counties on the *W.G. Jackson* at its home port in Muskegon. Seven more Michigan counties and three states (Illinois, Wisconsin, and Indiana) have been visited by the *W.G. Jackson* through away trips. The *D.J. Angus* has visited eight ports of call in Michigan and one port in Indiana. Throughout the years, there have been groups on the *D.J. Angus* from 28 counties in Michigan (Figure 5).

Science Instructors represent AWRI's outreach and education programs at the STEAM Along the Lakeshore festival in Spring 2022

The vessel program staff also participated in three West Michigan festivals with an information table and the opportunity to experience hands-on activities typically conducted onboard our cruises. The festivals were: Lakeshore Earth Day Festival (Grand Haven, April 2022), STEAM Along the Lakeshore (Muskegon, May 2022), and the Macatawa Water Festival (Macatawa, August 2022).

COVID-19 Response

The 2022 season continued to be impacted by the COVID-19 pandemic in several ways, though significantly less so than the 2021 season. The health and safety of visitors, staff, and students continued to be our highest priority. The AWRI vessel staff developed protocols based on existing state, local, GVSU, Coast Guard, and Centers for Disease Control (CDC) requirements and guidelines. All of the guidelines shifted throughout the year. The program started the season with the same guidelines as fall 2021:

- All passengers were required to fill out a version of GVSU's Visitor Self-Assessment, which certified that they were neither experiencing symptoms of COVID-19 nor had a recent exposure.
- On the vessels, masks were required at all times in the indoor lab spaces for all staff, teachers, chaperones, and students, regardless of vaccination status. Masks were encouraged but not required in outdoor spaces.
- Masks were required at all times in the Lake Michigan Center (including the classroom, restrooms, and other common areas) for all staff and visiting teachers, chaperones, and students, regardless of vaccination status.
- On vessels, the AC was kept off and the windows and doors kept open at all times, to maximize ventilation and air flow indoors.
- Vessels were sanitized per the CDC guidelines for commercial vessels prior to passengers boarding.
- Efforts were made to maintain social distancing between guests and AWRI staff to the extent possible to minimize the amount of time staff spent within 6 feet of passengers, including making adaptations to the cruise activities. For example, any activities done indoors were conducted with no more than half the maximum capacity of the vessel, and any full group activities were done on the aft deck.

Over the course of the spring season, GVSU discontinued the self-assessment for staff and visitors, and lifted mask requirements. The Coast Guard also lifted their mask mandate, so masks became optional for our programs. The vessel program requested that participants not join the cruise if they had symptoms consistent with COVID-19. We continued our internal, vessel-program specific protocols through the rest of the programming year.

The shifting requirements required more frequent and intentional communications with groups to ensure that visitors knew what was required of them when coming on a cruise. We also had some schools cancel cruises late in the season due to our required COVID-19 protocols, creating open time slots in the Spring schedule.

Though we are not aware of any passengers contracting COVID-19 during a vessel experience, there were some staff who became ill with COVID-19 which necessitated some last-minute staffing changes.

W.G. Jackson Away Trips

In addition to providing aquatic science field trips out of her home port in Muskegon, the *W.G. Jackson* has visited 34 additional ports of call and every state around Lake Michigan (Figure 5). These away trips (formerly called the "Making Lake Michigan Great") involved using the AWRI research and education vessels to spread the word about stewardship and restoration activities in the Lake Michigan basin starting in 1998. Previously a large component of the vessel program's activity, funding has generally not been available for the program since 2018. Funding from hosting partners allowed the tour to continue in 2019 to ports of call in Hammond, IN and Michigan City, IN, but due to the COVID-19 pandemic, no tours occurred in 2020 or 2021. In 2022, planning began for the *W.G. Jackson* to return to these two ports of call in June, but the trips were cancelled due to budget constraints. The program will continue to consider away trip opportunities as budgets and staff capacity permit.

Outreach Program based in the R.B. Annis Educational Foundation Classroom

AWRI continues to reach additional students through activities in the R. B. Annis Educational Foundation classroom at the Lake Michigan Center. Funds from the R. B. Annis Educational Foundation established an endowment to support classroom activities. AWRI hosts numerous K-12 classes and other groups in the classroom each year. Classroom programming features activities designed by our AWRI outreach staff, and draws upon other environmental curricula such as Project WET (Water Education Today), Project Learning Tree, the Global Learning and Observations to Benefit the Environment (GLOBE), and more. In some cases, groups are divided in two, with half the group going on the *W.G. Jackson* and the other half staying in the classroom for hands-on activities that extend their learning about water science. Then the groups alternate, making it a complete day of comprehensive activities.

In 2022, 22 classroom programs were offered to nine different groups. Six were groups taking trips on the *W.G. Jackson.* One group was a cohort of teachers from across the state attending a professional development program titled the Mid-Michigan Watershed Connections. The program, funded by a NOAA B-WET grant, enables teachers to engage their students in learning about watersheds, their importance, and how to protect them. The classroom was again the site of a three-day Algae Course sponsored by EGLE with Dr. Rick Rediske as the main instructor. Water treatment personnel from throughout Michigan were in attendance. AWRI also hosted the "Design Thinking for Social Product Innovation" course offered by the

EGLE Plankton/Algae Course activities taking place in the R.B. Annis Foundation Classroom

GVSU Frederick Meijer Honors College. The students toured the AWRI research labs and *W.G. Jackson* and learned about the mission and history of AWRI. In the classroom, the students discussed social innovations and heard presentations from AWRI researchers Dr. Rick Rediske and Dr. Bopi Biddanda.

In all, 514 people were served through our classroom programming in 2022. While an improvement over 2021 (in which only one school and one GVSU course utilized the classroom), this is still well below pre-pandemic levels (2019), when the classroom program served 1964 people through 83 events. We anticipate that over time classroom use will return to more typical levels.

AWRI summer intern Audrey Whittaker provides instruction during an outdoor classroom program

On the curriculum side, exciting changes were made to landside programming to complement the students' vessel experiences. Recognizing the high value of outdoor education and to better incorporate place-based education principles, all 4-12 grades "classroom" programming for the 2022 season was designed for the outdoors. Students actively engaged in the land/water connection of the Muskegon River watershed through interactive activities using Project WET, GLOBE, and other environmental education curriculum materials. For example, students explored the concept of a watershed by playing an interactive water cycle game, building a 3D watershed model, and investigating how water flowed across the land. Much akin to the water quality monitoring occurring on the vessels, students examined how to monitor conditions on the land, such as taking surface and soil temperatures, measuring tree heights, and making phenological observations. Additionally, outdoor programming offered the opportunity to demonstrate best practices in place-based environmental education pedagogy to teachers, with the hope that they may take these methods back to their schools. Many returning teachers commented that their students were very engaged in the outdoor-based learning activities.

Students collect surface temperature data on the shoreline of Muskegon Lake during an outdoor classroom program

Support Materials

The education program has developed an instructional video (*Exploring the Lakes*) and instructor's guide. The AWRI outreach and education website contains the Instructor/Student Manual, program information, and directions of how to schedule the vessels.

Students can also explore real-time data at the Muskegon Lake Observatory website. This GLRI/NOAA-funded project provided for deployment of a buoy with sensors in Muskegon Lake. Water sensors measure over 13 parameters including temperature, oxygen, nutrients, light, pH, conductivity, algal pigments, bacterial pigments, and current speed and direction. Air sensors measure 8 parameters including temperature, wind, humidity, and precipitation. Information is shared through a live data display at the Lake Michigan Center as well as web-based observing networks.

Science Instructor Steve Jablonski assists students with benthic macroinvertebrate samples on the W.G. Jackson. Photo Credit: School News Network/Dianne Carroll Burdick

Table 1. History of Participants Aboard the *W.G. Jackson*

Year	Number of Events	Total Number Carried[1]	High School Students	Middle School Students[2]	Elementary School Students	GVSU Students	Adults[3]	Visitors (dockside)
1996	111	3,188	94	305	105	203	1,098	1,383
1997	148	3,290	457	794	1,252	76	649	62
1998	199	4,734	216	627	1,447	128	1,318	998
1999	220	5,617	240	898	1,403	101	2,146	829
2000	204	5,198	381	1,500	1,083	77	1,091	1,066
2001	211	5,034	275	814	1,385	216	1,628	716
2002	205	4,548	235	1,595	1,106	72	1,244	296
2003	159	4,021	262	1,076	1,117	168	778	620
2004	129	2,937	92	1,049	664	95	722	315
2005	144	3,386	291	968	904	79	839	305
2006	148	3,694	342	1,029	851	64	906	502
2007	166	3,550	574	1,187	695	206	781	107
2008	144	3,546	366	1,226	687	108	854	305
2009	120	2,901	199	1,043	355	132	878	294
2010	122	3,216	226	1,090	599	27	863	411
2011	138	3,337	225	884	651	91	1,235	251
2012	142	3,229	303	1,132	613	58	926	197
2013	151	3,494	239	995	738	63	1,257	202
2014	135	3,148	228	1,095	622	71	931	201
2015	148	3,296	311	925	922	25	1,104	9
2016	130	3,308	206	1,302	903	31	753	113
2017	132	3,144	148	1,000	904	47	1,023	22
2018	152	3,443	297	1,049	1,002	59	1,018	18
2019	141	2,996	286	1,277	680	56	685	12
2020[4]	0	0	0	0	0	0	0	0
2021	33	635	137	331	34	16	117	29
2022	83	1,849	98	868	382	38	437	26
Total	**3,815**	**90,739**	**6,728**	**26,059**	**21,104**	**2,307**	**25,281**	**9,289**

[1] Not including ship's crew
[2] Middle School includes Grades 6-8, Elementary includes Grades 4-5
[3] Includes non-GVSU college students as well as adult groups and adult chaperones
[4] Due to the COVID-19 pandemic, the vessel did not operate in 2020 and operated in the Fall 2021 season only

Table 2. History of Participants Aboard the *D.J. Angus*

Year	Number of Events	Total Number Carried[5]	High School Students	Middle School Students[6]	Elementary School Students	GVSU Students	Adults[7]	Visitors (dockside)
1986	35	846	262	0	0	199	175	210
1987	67	1,604	415	98	187	353	251	300
1988	120	2,278	252	334	222	614	550	306
1989	132	2,903	308	481	344	609	256	905
1990	129	3,532	490	311	508	561	436	1,226
1991	137	4,393	518	390	571	604	503	1,807
1992	134	3,455	543	327	565	550	598	872
1993	147	3,632	417	544	695	616	676	684
1994	169	3,589	516	334	1,084	576	763	316
1995	231	5,057	462	510	1,609	593	1,491	392
1996	137	3,080	373	386	813	571	792	145
1997	150	3,030	493	659	790	580	508	0
1998	144	2,942	562	587	666	406	413	308
1999	146	2,919	288	575	969	512	552	23
2000	163	3,661	672	938	600	500	544	407
2001	158	3,124	349	1,054	540	665	486	30
2002	149	3,111	487	1,005	707	496	416	0
2003	123	2,520	314	724	653	448	381	0
2004	123	2,440	186	627	746	552	317	12
2005	135	2,689	322	932	469	497	469	0
2006	144	2,928	178	1,063	615	529	468	75
2007	131	2,764	281	1,028	547	333	465	110
2008	122	2,560	201	995	611	341	412	0
2009	105	2,282	219	880	499	384	300	0
2010	114	2,617	131	937	479	341	561	168
2011	102	2,126	213	837	370	378	328	0
2012	139	2,812	226	1,021	465	371	679	50
2013	120	2,481	258	938	460	343	482	0
2014	130	2,558	290	1,033	377	332	526	0
2015	123	2,555	311	919	462	352	511	0
2016	134	2,647	450	880	383	371	563	0
2017	109	2,211	237	891	359	332	392	0
2018	107	2,249	248	980	322	317	382	0
2019	110	2,235	137	1,121	282	368	327	0
2020[8]	0	0	0	0	0	0	0	0
2021	17	330	53	132	0	98	47	0
2022	70	1,331	166	432	258	263	212	0
Total	**4,506**	**97,491**	**11,828**	**24,903**	**19,227**	**15,955**	**17,232**	**8,346**

[5] Not including ship's crew
[6] Middle School includes Grades 6-8, Elementary includes Grades 4-5
[7] Includes non-GVSU college students as well as adult groups and adult chaperones
[8] Due to the COVID-19 pandemic, the vessel did not operate in 2020 and operated in the Fall 2021 season only

Table 3. History of Participants Aboard both vessels

Year	Number of Events	Total Number Carried[9]	High School Students	Middle School Students[10]	Elementary School Students	GVSU Students	Adults[11]	Visitors (dockside)
1986[12]	35	846	262	0	0	199	175	210
1987	67	1,604	415	98	187	353	251	300
1988	120	2,278	252	334	222	614	550	306
1989	132	2,903	308	481	344	609	256	905
1990	129	3,532	490	311	508	561	436	1,226
1991	137	4,393	518	390	571	604	503	1,807
1992	134	3,455	543	327	565	550	598	872
1993	147	3,632	417	544	695	616	676	684
1994	169	3,589	516	334	1,084	576	763	316
1995	231	5,057	462	510	1,609	593	1,491	392
1996[13]	248	6,268	467	691	918	774	1,890	1,528
1997	298	6,320	950	1,453	2,042	656	1,157	62
1998	343	7,676	778	1,214	2,113	534	1,731	1,306
1999	366	8,536	528	1,473	2,372	613	2,698	852
2000	367	8,859	1,053	2,438	1,683	577	1,635	1,473
2001	369	8,158	624	1,868	1,925	881	2,114	746
2002	354	7,659	722	2,600	1,813	568	1,660	296
2003	282	6,541	576	1,800	1,770	616	1,159	620
2004	252	5,377	278	1,676	1,410	647	1,039	327
2005	279	6,075	613	1,900	1,373	576	1,308	305
2006	292	6,622	520	2,092	1,466	593	1,374	577
2007	297	6,314	855	2,215	1,242	539	1,246	217
2008	266	6,106	567	2,221	1,298	449	1,266	305
2009	225	5,183	418	1,923	854	516	1,178	294

[9] Not including ship's crew

[10] Middle School includes Grades 6-8, Elementary includes Grades 4-5

[11] Includes non-GVSU college students as well as adult groups and adult chaperones

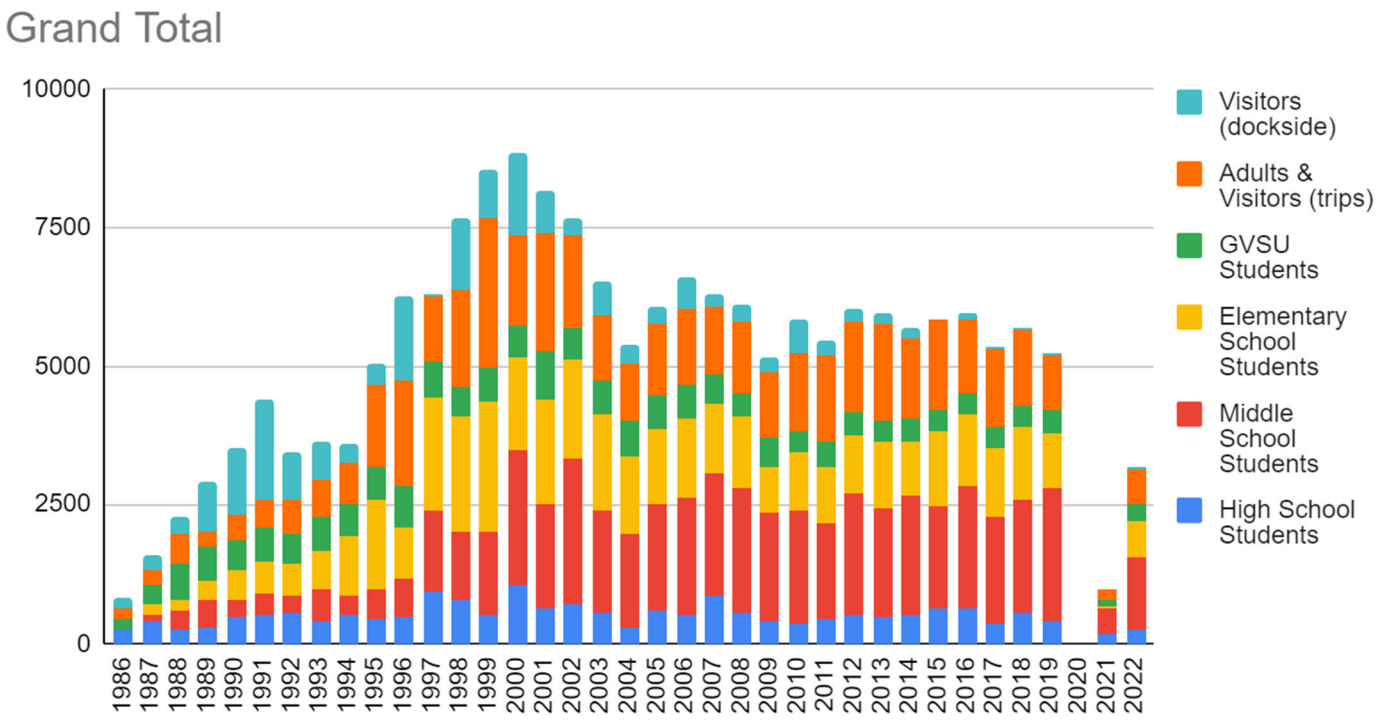
[12] The D.J. Angus was dedicated in June 1986 and began operations in July 1986

[13] The W.G. Jackson was dedicated in June 1996 and began operations in July 1996

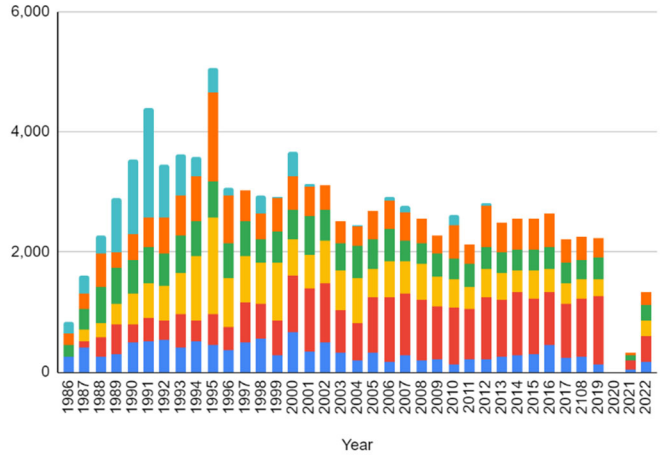
Year	Number of Events	Total Number Carried	High School Students	Middle School Students	Elementary School Students	GVSU Students	Adults	Visitors (dockside)
2010	236	5,833	357	2,027	1,078	368	1,424	579
2011	240	5,463	438	1,721	1,021	469	1,563	251
2012	281	6,041	529	2,153	1,078	429	1,605	247
2013	271	5,975	497	1,933	1,198	406	1,739	202
2014	265	5,706	518	2,128	999	403	1,457	201
2015	271	5,851	622	1,844	1,384	377	1,615	9
2016	264	5,955	656	2,182	1,286	402	1,316	113
2017	241	5,355	385	1,891	1,263	379	1,415	22
2018	259	5,681	545	2,029	1,324	376	1,400	18
2019	251	5,231	423	2,398	962	424	1,012	12
2020[14]	0	0	0	0	0	0	0	0
2021	50	965	190	463	34	114	164	29
2022	153	3,180	264	1300	640	301	649	26
Total	**8,321**	**188,219**	**18,556**	**50,962**	**40,331**	**18,262**	**42,513**	**17,635**

[14] Due to the COVID-19 pandemic, the vessels did not operate in 2020 and operated in the Fall 2021 season only

Figure 1. Number of Participants Each Year by Age Group



Angus



Jackson

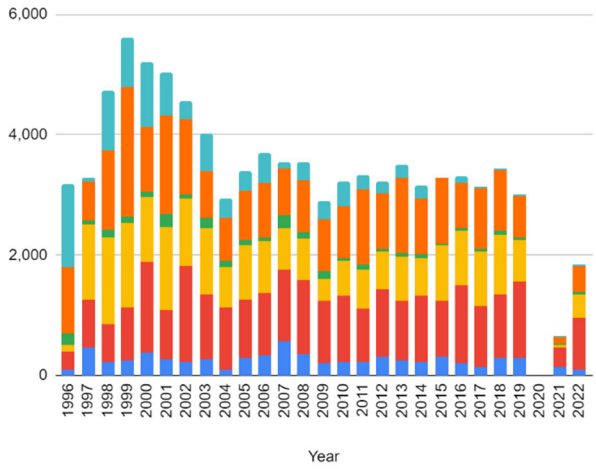


Figure 2. Percentage of Groups by Age Aboard AWRI vessels

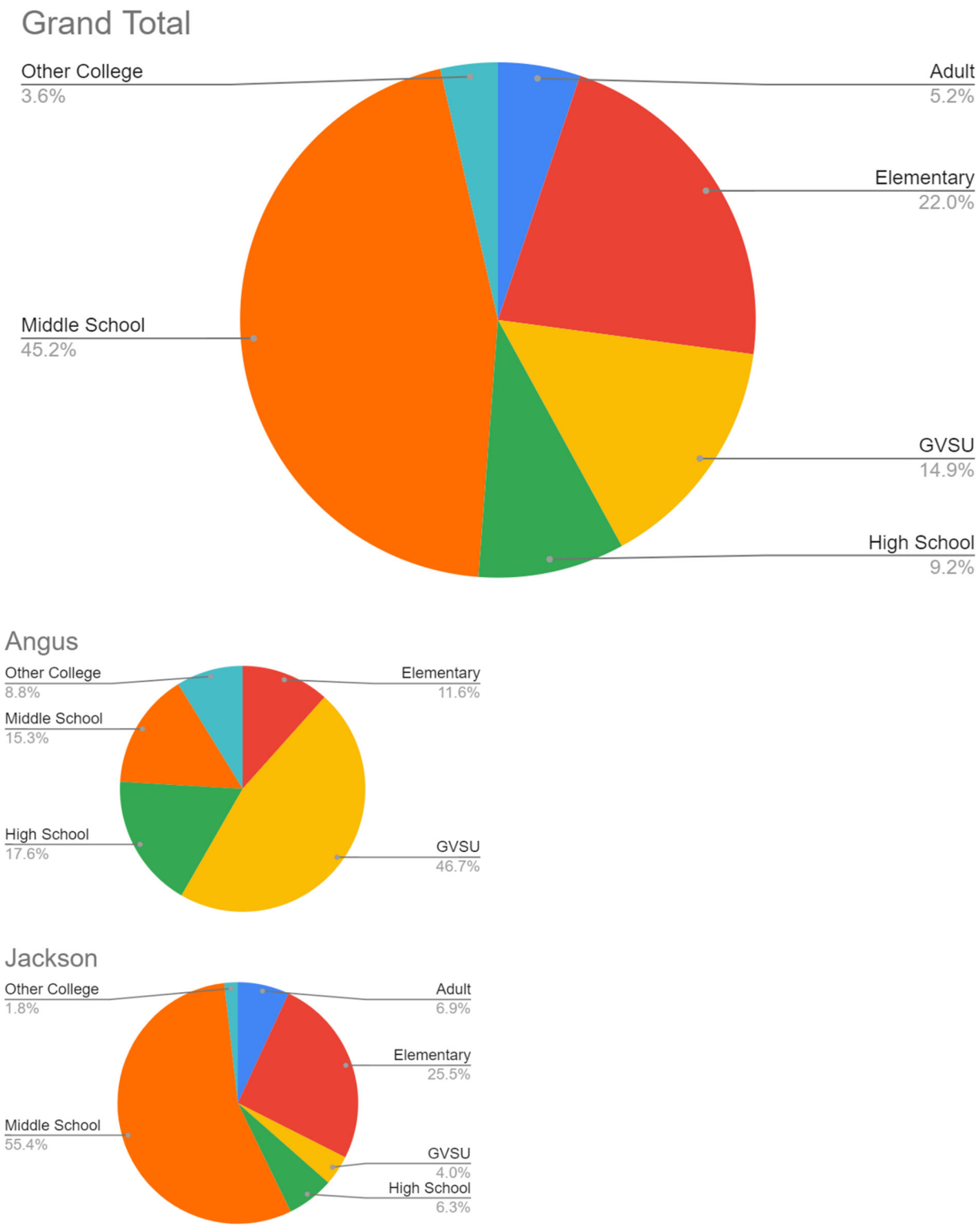
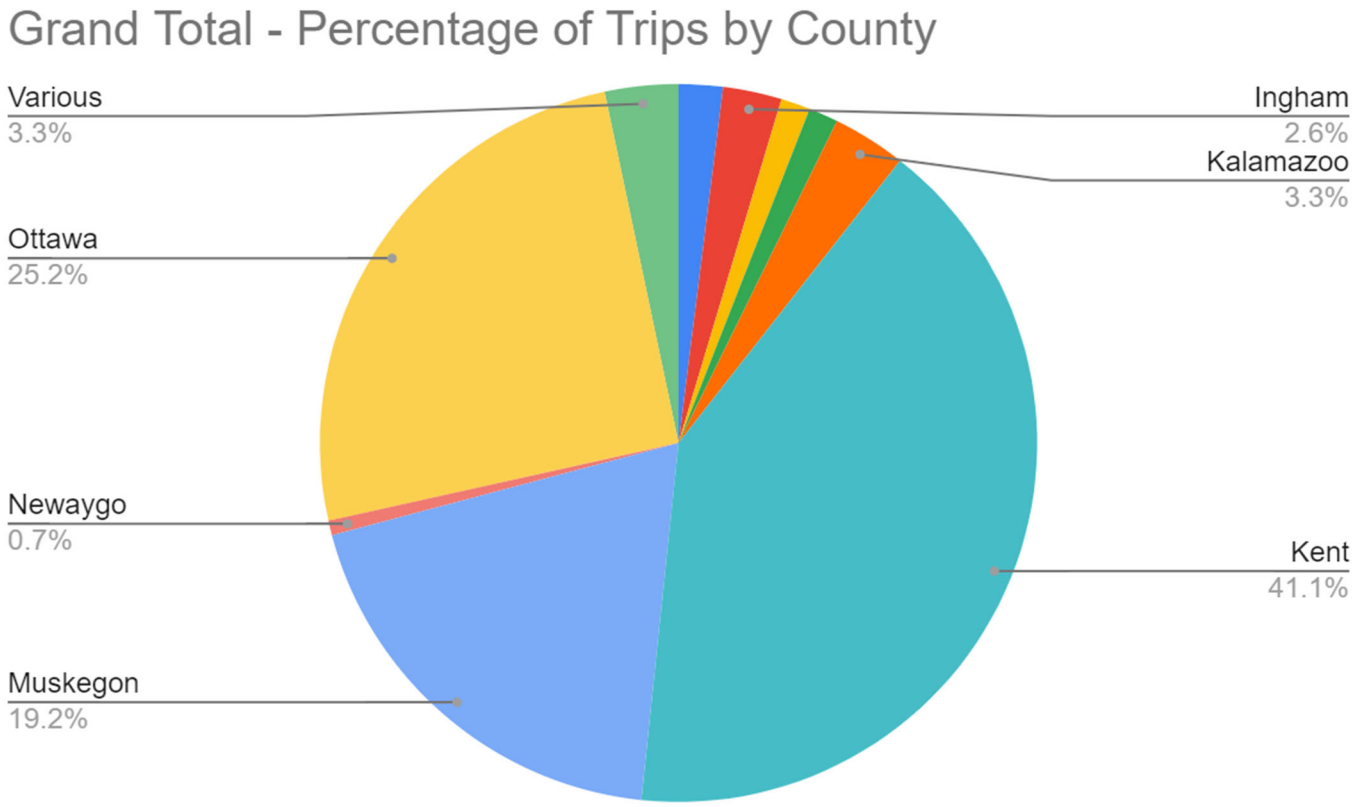


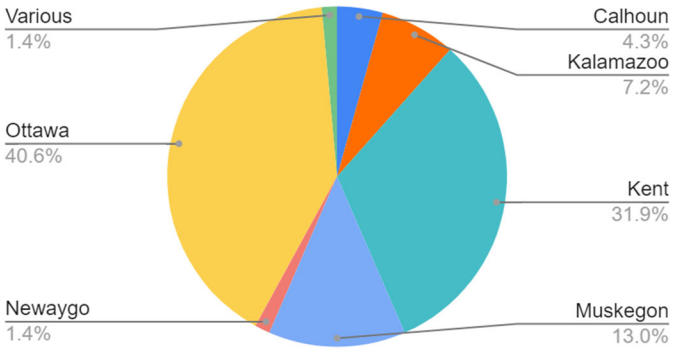
Table 4. Number of Groups listed by Michigan County Aboard AWRI Vessels

County	Angus	Jackson	Grand Total
Allegan	1	1	2
Calhoun	3		3
Ingham		4	4
International		1	1
Ionia		2	2
Kalamazoo	5		5
Kent	22	40	62
Muskegon	9	20	29
Newaygo	1		1
Ottawa	28	10	38
Various	1	5	6
Grand Total	**70**	**83**	**153**

Figure 3. Percentage of Trips by Michigan County Aboard AWRI vessels



Angus



Jackson

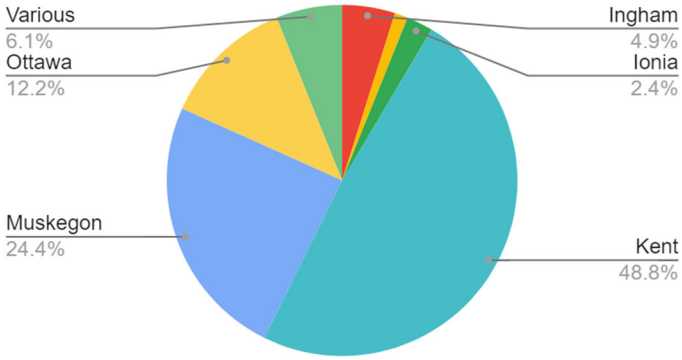
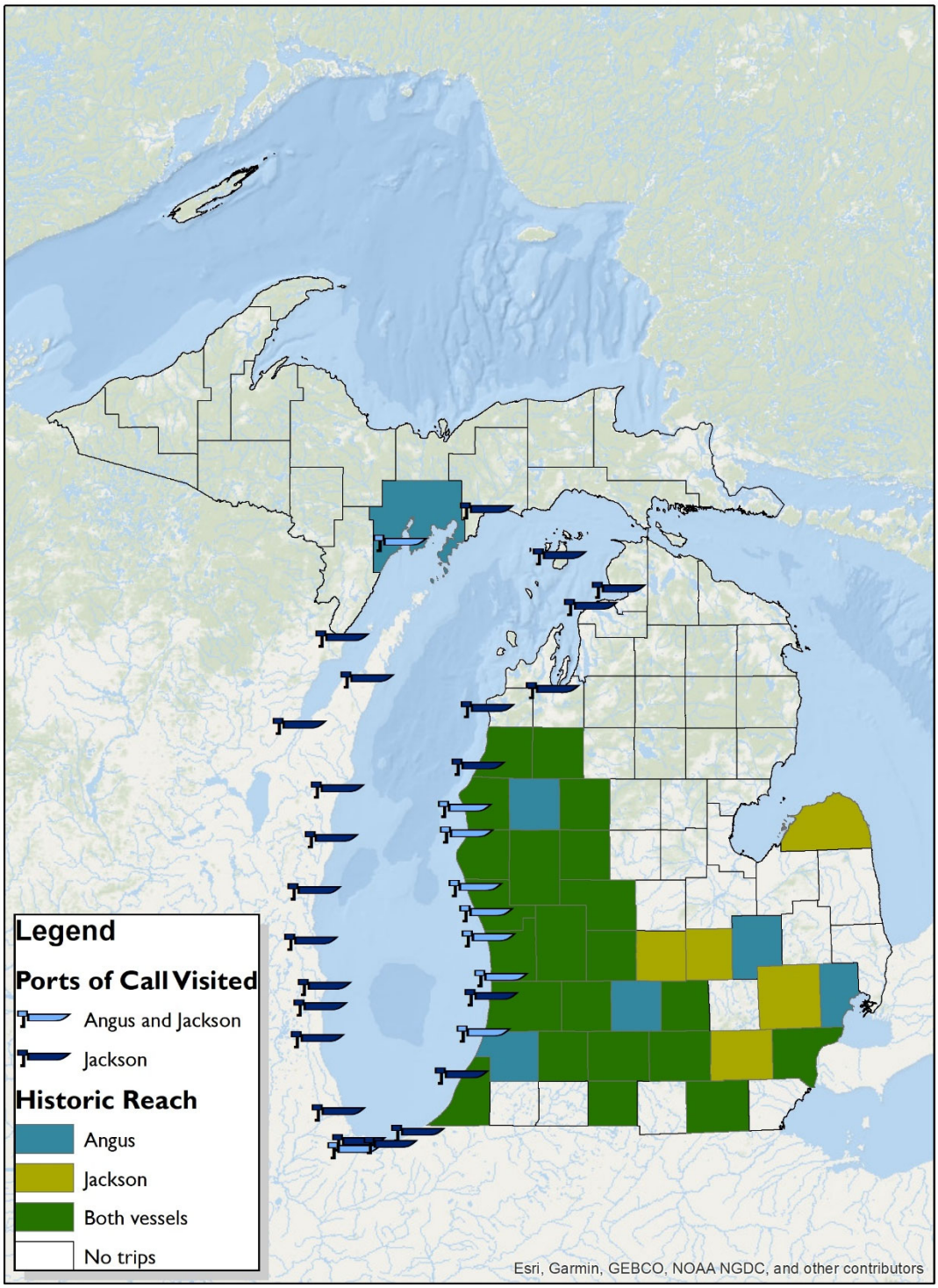


Figure 4. Map of the Historic Reach of the Vessel Program



Geographic representation of overall usage of the *D.J. Angus* and *W.G. Jackson* from 1986 to 2022. Ports of call visited in Lake Michigan are represented by boat icons. Michigan counties are color coded if groups from that county have used the vessels.

Table 5. Number of groups and individuals by age group using the R.B. Annis Foundation Educational Classroom

Age Group	Number of Participants	Number of Groups
Adult	34	2
Elementary	97	4
High School	14	1
Middle School	343	14
Grand Total	**488**	**21**

Figure 5. Percentage of R.B. Annis Foundation Educational Classroom use by age group

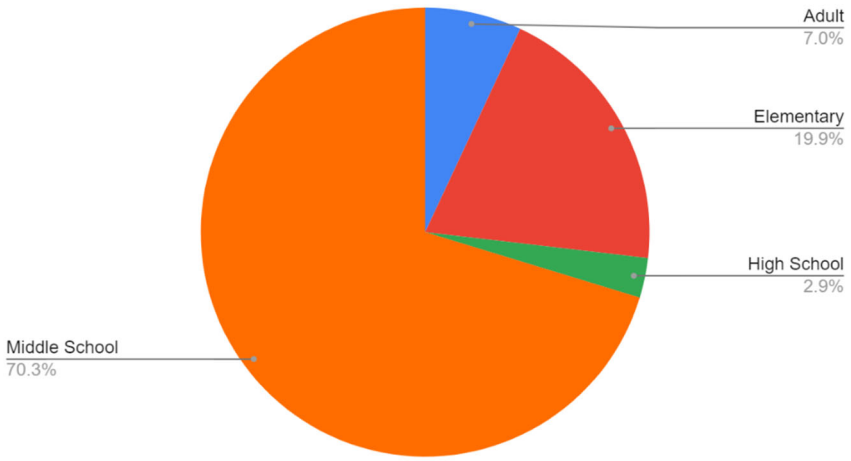


Table 6. Number of groups by county using the R.B. Annis Educational Foundation classroom

County of Origin	Number of Groups
Ingham	2
Kent	9
Muskegon	8
Various	2
Grand Total	**21**

2023 Outlook and Goals

Going into the 2023 season, the AWRI vessel program is well-positioned to build on past successes and grow the program into the future. Many opportunities exist for the program to evolve to meet the needs of today's learners and incorporate the most pressing science into the vessel curriculum. Challenges (internal and external) also exist that pose threats to realizing this potential.

Students sort through a PONAR grab sample on the W.G. Jackson

Opportunities

Significant leadership changes in the program present opportunities for the program to expand on prior program successes. Long-time Educational and Vessel program leader Janet Vail and long-time Fleet Captain Tony Fiore retired in 2021. The foundation they established have provided the new program leadership the opportunity to grow the programs in new ways.

Additional staff changes in 2022 included the hiring of new instructors (4), deckhands (1), engineers (1), and captains (2). The new hires quickly gelled with returning staff and have resulted in very positive team dynamics and energy among the team members. Previously, most Science Instructors were retired educators, but some of the new hires were midcareer individuals, resulting in more intergenerational diversity on staff (which was identified as an area for potential growth in the 2022 report). Additionally, one Science Instructor was promoted to Lead Instructor of the *W.G. Jackson*, a role that has not been filled for several years. This has made for more efficient and clear workflow and roles.

In 2022, we made significant progress towards filling a knowledge gap through research conducted by our summer intern. Demographic and other data was collected for all schools participating in the vessel program for the last five years (2017-2021). These data include each school's Title I status; percentage of families in the district with income below the poverty line; percentage of non-white students in the school; percentage of non-white students in the district; percentage of students with a disability in the district; if the school is located in a suburban, urban or rural area; and the distance traveled to participate in the program. We also began to analyze and track which nearby schools have not used the vessels in recent years. Further analysis of this data is needed to better understand the vessel program's current reach. Data collection and analysis will now to be done annually to understand any shifts in the program's reach. As diversity, equity, inclusion and belonging (DEIAB) are AWRI and GVSU priorities, the educational programs will work to build relationships, and identify and remove barriers to more diverse populations participating in our programming, especially among Muskegon schools.

Though some groups are well-prepared for their cruises and to continue their learning in the classroom after a cruise, this is highly varied across visiting groups. Some teachers draw from our available support materials and their own research to construct larger learning arcs across the school year for their students. In contrast, some teachers lack the resources to expand their students' experience beyond the 2.5 hours onboard. Understanding that this variability will always be the case, AWRI Education staff are developing additional support materials, including optional pre- and post-cruise resources for teachers to utilize in their classrooms to build on their group's experience on the vessels and extend their learning. Our intention is that this will be particularly supportive for teachers at less resourced schools who may not have capacity for additional curriculum development, or for whom environmental science and place-based learning is outside of their training and expertise.

The educational program is very fortunate to have access to the many AWRI researchers working in aquatic science. Further integration and connection with the research of these scientists would boost the impact and relevance of the educational curriculum. Incorporating more real-world data and high profile contemporary environmental issues into the educational experience will further distinguish our already-unique vessel program.

Challenges

Maintaining a fully staffed crew requires perennial effort. Because of the short but intensive seasons for vessel operations, as well as salary constraints, finding and keeping employees can be difficult. For example, two recently hired science instructors do not plan to return for the 2023 season after finding more stable employment. The great number of new staff hired in 2022 also meant a significant amount of time was spent onboarding and training new staff.

Racial and cultural diversity is a major focus of GVSU and AWRI. It is widely known that an educational experience is more meaningful for students of color to see people who look like them in science roles. In addition, it offers underserved populations a way of seeing themselves in these careers. Historically, the vessel crew and science education staff have reflected the relatively homogeneous racial and cultural diversity of the two professions. Clearly, this limits our program's ability to be welcoming and accessible for underserved groups participating in our educational programs. Since hiring new staff will continue to be a need, increasing the cultural diversity on our staff is a priority.

Anecdotal evidence suggests that most schools participating in our programs have more resources and have greater representation in STEM than groups not participating in our educational programs. The educational program has not historically tracked demographic data for participants, leaving a dearth of information about who is being served by our programs, and in particular what proportion of participants are from historically underrepresented groups in science education. Without a baseline understanding of our reach, it is a challenge to assess the status of our engagement with each demographic group. It also makes it challenging to know where to direct our DEI efforts or how we would know if we were making progress. The aforementioned data project has helped us make progress in addressing this challenge.

The vessel schedule is approaching but short of pre-pandemic levels. Whereas in 2019 and earlier, there was often a waitlist to schedule vessel trips, in 2022 the vessel schedules had availability. In fact, some days during the height of the season the vessels had no trips or only one trip per day. Some long-time vessel program attendees have not been back on the roster since operations resumed in Fall 2021. It is a long-term goal of the vessel program to both reestablish fruitful past relationships as well as build new ones with local schools who have not used the vessels historically.

Other external challenges include maintaining numbers served in spite of K-12 budget cuts and increasing class sizes in some school districts. For some schools, the cost and logistics of transportation have become prohibitive. In fact, busing is perhaps the biggest barrier to returning to a full, pre-pandemic schedule. Many schools have booked trips and later cancelled trips when busing was not available, leaving gaps on the schedule. Others are forced to book multiple half days, instead of bringing multiple classes in a single day, as was previously typical and made managing the vessel calendar more efficient. The reduced trip schedule has contributed, in part, to staff turnover. To address this challenge, during the registration process, schools are encouraged to book full days when possible, and shorter cruises are offered as alternatives when time constraints present a challenge (for example, 2 hour cruises instead of the standard 2.5 hour cruise). We will continue to explore alternatives, but there are relatively few ways that AWRI's program can address the systemic issues that limit the ability of schools to participate in field trips of all kinds, not just with our program.

One challenge unique to the 2022 season was the lift bridge in Grand Haven was closed through early May due to maintenance. This delayed the start for the *W.G. Jackson* season, since the vessel had overwintered at a Grand Haven marina, could not navigate underneath the lift bridge, and could not return to Muskegon until the bridge construction was completed. Bridge maintenance also necessitated that the *D.J. Angus* operate out of Keenan's Marina rather than Harbor Island and use alternative cruise routes for the first weeks of the season. Staff adapted to and overcame these challenges, but it made for a difficult beginning of the season and required a great deal of communication with visiting groups on location changes. The Fleet Captain determined that for the 2022-2023 offseason, the *W.G. Jackson* would overwinter in Muskegon, so this will not pose an issue this year despite the bridge construction continuing.

Vessel maintenance and upgrades continue to be performed regularly with passenger safety and efficient operation being top priorities. Operations staff will continue to be responsive to water level variations and maintenance needs. During 2019, unusually high-water levels resulted in flooding on the access road to the *D.J. Angus* on Harbor Island in Grand Haven. Although temporary, this did create a disruption in operations. High water levels also required making modifications to the *W.G. Jackson* dock at the Lake Michigan Center.

Program Goals

- Near term
    - Deliver high quality educational programs in a cost-effective manner.
    - Continue development and enhancement of curriculum for the vessel and classroom programs, with emphasis on the Michigan Science Standards.
    - Continue to build a highly effective and diverse team of science instructors, scaled to the program's demands.
    - Update instructional equipment and graphics as needed and appropriate.
    - Continue to achieve a high level of maintenance and safety, and evaluate future infrastructure changes that may be needed for both vessels.
- Mid term
    - Enhance curriculum connections between vessel/classroom programs and the current research of AWRI scientists.
    - Review vessel program evaluation and demographic data and assess through a DEIAB lens.
    - Develop pre- and post-cruise resources to enhance student learning and extend their experience beyond their time on the vessels.
    - Conduct/coordinate professional development for K-12 educators in response to needs.
- Long term
    - Explore opportunities for integrating the arts into AWRI outreach and education programs.
    - Explore opportunities for expanded funding of the outreach program.

Appendices

AWRI Publications Related to Use of AWRI research vessels

Altenritter, M.E.L., A.C. Wieten, C.R. Ruetz III, and K.M. Smith. 2013. Seasonal spatial distribution of juvenile lake sturgeon in Muskegon Lake, Michigan. Ecology of Freshwater Fish 22: 467-478.

Anderson, V. ., K.L. Wendt, J.B. Caughron, H.P. Matlock, N. Rangu, F.Z. Najar, A.N. Miller, M.R. Luttenton, and R.H. Cichewicz. 2022. Assessing microbial metabolic and biological diversity to inform natural product library assembly. Journal of Natural Products 85:1079-1088.

Bhagat, Y., and C.R. Ruetz III. 2011. Temporal and fine-scale spatial variation in fish assemblage structure in a drowned river mouth system of Lake Michigan. Transactions of the American Fisheries Society 140:1429-1440.

Biddanda, B., Dila, D., Weinke, A., Mancuso, J., Villar-Argaiz, M., Medina-Sánchez, JM., González-Olalla, JM., and P. Carrillo. 2021. Housekeeping in the Hydrosphere: Microbial Cooking, Cleaning and Control Under Stress. Life doi:10.3390/life11020152

Biddanda, B., S. Kendall, A. Weinke, I. Stone, N. Dugener, S. Ruberg, J. Leidig, E. Smith, M. Berg, and G. Wolffe. 2021. Muskegon Lake Observatory Buoy Data: Muskegon Lake, Michigan: 2011-2019. Environmental Data Initiative https://doi.org/10.6073/pasta/d1ef6101a1870a0b0bd54d3914dc13dc

Biddanda, B.A., A.D. Weinke, S.T. Kendall, L.C. Gereaux, T.M. Holcomb, M.J. Snider, D.K. Dila, S.A. Long, C. VandenBerg, K. Knapp, D.J. Koopmans, K. Thompson, J.H. Vail, M.E. Ogdahl, Q. Liu, T.J. Johengen, E.J. Anderson and S.A. Ruberg. 2018. Chronicles of Hypoxia: Time-series buoy observations reveal annually recurring seasonal basin-wide hypoxia in Muskegon Lake – a Great Lakes estuary. Journal of Great Lakes Research 44:219-229.

Dila, K.D. and B.A. Biddanda. 2015. From land to lake: contrasting microbial processes across a Great Lakes gradient of organic and nutrient inventories. Journal of Great Lakes Research 41: 75-85. DOI:10.1016/j.jglr.2015.04.014

Gezon, N.R., D.W. Haywick, J.M. Sanders, I. Hewson, and K.B. Strychar. In Press. Surveying the Circular Rep Encoding Single Stranded (CRESS) DNA viral consortium in quagga mussels (Dreissena rostriformis bugensis) and sediment from the central Lake Michigan benthos. Journal of Great Lakes Research.

Gillett, N. and A.D. Steinman. 2011. An analysis of long-term phytoplankton dynamics in Muskegon Lake, a Great Lakes Area of Concern. Journal of Great Lakes Research 37: 335-342.

Harris, B.S., C.R. Ruetz III, T.J. Ellens, B.A. Biddanda, and A.D. Weinke. 2020. Adult lake sturgeon (Acipenser fulvescens Rafinesque, 1817) occurrence in the Muskegon River system, a Lake Michigan

drowned river mouth, USA. Journal of Applied Ichthyology 36(5):547-558. https://doi.org/10.1111/jai.14076.

Janetski, D.J., C.R. Ruetz III, Y. Bhagat, and D.F. Clapp. 2013. Recruitment dynamics of age-0 yellow perch in a drowned river mouth lake: assessing synchrony with nearshore Lake Michigan. Transactions of the American Fisheries Society 142(2): 505-514.

Kleindl, P.M. and A.D. Steinman. 2021. Contrasting trajectories in macrophyte community development after shoreline restoration: water level obscures trends. Aquatic Botany 169: 103327.

Liu, B., C.E. McClean, D.T. Long, A.D. Steinman, and R.J. Stevenson. 2018. Eutrophication and recovery of a lake inferred from sedimentary diatoms originating from different habitats. Science of the Total Environment, 628-629: 1352-1361. doi:10.1016/ j.scitotenv.2018.02.174

Liu, Q., E.J. Anderson, Y. Zhang, A.D. Weinke, K.L. Knapp and B.A. Biddanda. 2018. Modeling reveals the role of coastal upwelling and hydrologic inputs on biologically distinct water exchanges in a Great Lakes estuary. Estuarine, Coastal and Shelf Science, 209: 41-55. doi:10.1016/j.ecss.2018.05.014

Mancuso, L.J., A. D. Weinke, I.P. Stone, S.E. Hamsher, M. Villar-Argaiz and B. A. Biddanda. 2021. Cold and Wet: Diatoms dominate the phytoplankton community in a year of anomalous weather in a Great Lakes estuary. Journal of Great Lakes Research. 47: 1305-1315. https://doi.org/10.1016/j.jglr.2021.07.003

Mancuso, L.J., A. D. Weinke, I.P. Stone, S.E. Hamsher, M.M. Woller-Skar, E.B. Snyder, and B. A. Biddanda 2021. Bloom and burst: Historical trends of harmful algal blooms in Muskegon lake, Michigan, a Great lakes estuary. Freshwater Science. 40: 463-477. https://www.journals.uchicago.edu/doi/full/10.1086/716236

Nelson, W. and A.D. Steinman. 2013. Changing trends in benthic communities in a coastal drowned river mouth lake, a Great Lakes Area of Concern. Journal of Great Lakes Research 39: 7-18.

Ogdahl, M.E. and A.D. Steinman. 2014. Factors influencing macrophyte growth and recovery following shoreline restoration activity. Aquatic Botany 120: 363-370.

Salk, K.R., P.H. Ostrom, B.A. Biddanda, A.D. Weinke, S.T. Kendall and N.E. Ostrom. 2016. Ecosystem metabolism and greenhouse gas production in a mesotrophic northern temperate lake experiencing seasonal hypoxia. Biogeochemistry 131: 303-319. https://doi.org/10.1007/s10533-016-0280-y

Scott, J.W., Gunderson, K.G., Green, L.A., Rediske, R.R. and Steinman, A.D., 2021. Perfluoroalkylated substances (Pfas) associated with microplastics in a lake environment. Toxics, 9(5), 106.
(based on assessment of deployed microplastics in Muskegon Lake—the Jackson was used to deploy and retrieve the microplastic incubations).

Schmidt, M. L., B. A, Biddanda, A. D. Weinke, E Chiang, F. Januska, R. Props and V. J. Denef. 2020. Microhabitats are associated with diversity-productivity relationships in freshwater bacterial communities. FEMS Microbiology Ecology 96. doi: 10.1093/femsec/fiaa029

Steinman, A.D. and M. Ogdahl. 2004. An innovative funding mechanism for the Muskegon Lake AOC. Journal of Great Lakes Research 30: 341-343.

Steinman, A.D., M. Ogdahl, R. Rediske, C.R. Ruetz III, B.A. Biddanda, and L. Nemeth. 2008. Current status and trends in Muskegon Lake, Michigan. Journal of Great Lakes Research 34: 169-188.

Vail, J., A. Meyer, A. Weinke, and B. Biddanda. 2015. Water quality monitoring: Lesson plan for exploring time-series data. Michigan Science Teachers Association Journal 60(1): 37-48.

Wahl, H. E., D.B. Raudabaugh, E.M. Bach, T.S. Bone, M.R. Luttenton, R.H. Cichewicz, and A.N. Miller. 2018. What lies beneath? Fungal diversity at the bottom of Lake Michigan and Lake Superior. Journal of Great Lakes Research 44:263-270.

Weinke, A.D. and B.A. Biddanda. 2018. From bacteria to fish: Ecological consequences of seasonal hypoxia in a Great Lakes estuary. Ecosystems, 21: 426-442. doi: 10.1007/s10021-017-0160-x

Weinke, A.D., and B.A. Biddanda. 2019. Influence of episodic wind events on thermal stratification and bottom water hypoxia in a Great Lakes estuary. Journal of Great Lakes Research. 45: 1103-1112. https://doi.org/10.1016/j.jglr.2019.09.025

Weinke, A.D., S.T. Kendall, D.J. Kroll, E.A. Strickler, M.E. Weinert, T.M. Holcomb, D.K. Dila, A.A. Defore, M.J. Snider, L.C. Gereaux, and B.A. Biddanda. 2014. Systematically variable planktonic carbon metabolism along a land-to-lake gradient in a Great Lakes coastal zone. Journal of Plankton Research 36: 1528-1542.

Weinke, A., I. Stone, J. Greene, S. Woznicki, J. Cook, N. Dugener, and B. Biddanda 2022. Great Lakes Estuaries: Hotspots of Productivity, Problems and Potential. *Lakes Letter*, International Association for Great Lakes Research, Summer 2022, p. 9-10. https://pdf.live/edit?url=https%3A%2F%2Fiaglr.org%2Fll%2F2022-3-Summer_LL14.pdf&source=f&installDate=060222

Xie, L., R.R. Rediske, N.D. Gillett, J.P. O'Keefe, B. Scull, and Q. Xue. 2016. The impact of environmental parameters on microcystin production in dialysis bag experiments. Scientific Reports 6: 38722.

Vessel Program Staff

Administrative

Christina Catanese, Education Specialist
Mark Luttenton, Interim Director (August 2022 – current)
Alan Steinman, Allen and Helen Hunting Director and Professor (stepped down as Director as of August 2022)
Carl Ruetz, Interim Assistant Director (for Steinman)
Tonya Brown, AWRI Assistant
Roxana Taylor, AWRI Secretary

Science Instructors (vessels)

Paula Capizzi, Lead Science Instructor, *D.J. Angus*
Jamie Cross, Lead Science Instructor, *W.G. Jackson*
Doug Haywick, Science Instructor
Dave Helder, Science Instructor
Ann Hesselsweet, Science Instructor
Steve Jablonski, Science Instructor
Tom Jackson, Science Instructor
Bob Myers, Science Instructor
Diane Veneklasen, Science Instructor
Audrey Whittaker, Summer Intern

Outreach Education Instructors (classroom)

Amanda Syers, Science Education Specialist
Janet Vail, Research Scientist Emerita

Captains

Eric Hecox, Fleet Captain
Ossian Foley, Captain
Ed Perrault, Captain

Deckhands

Bill Breznau Sr., Engineer, *W.G. Jackson*
Dave Fisher, Engineer, *W.G. Jackson*
Tim Halloran, Deckhand, *W.G. Jackson*
Pete Hewett, Engineer, *D.J. Angus*

Support

Brad Nieboer, Marine Electrician

The 2023 AWRI Vessel Science Instructor Team

Groups using the *W.G. Jackson* in 2022

Allegan
Saugatuck High School - AP Environmental Science

Ingham
EGLE Plankton/Algae Course
Ingham Intermediate School District
Okemos High School
Senator Gary Peters visit

International
African Center for Aquatic Research and Education (ACARE)'s African Women in Science group

Ionia
Jefferson Elementary

Kent
Alto Elementary
Assumption of the Blessed Virgin Mary
Crestwood Middle School
East Grand Rapids Middle School
Eastern Middle School
Economicology
Grace Christian Academy
Grandville Public Schools - IMAGE program
GVSU - Master of Public Health (PH520)
Holy Trinity
Jack and Jill - Grand Rapids Chapter
John Ball Zoo staff
Murray Lake Elementary School
Rockford Christian
STEM Greenhouse summer camp
West Oakview Elementary School

Muskegon
Boys and Girls Club of Muskegon
Calvary Christian
Club 188 / Mount Zion Church of God in Christ summer program
Fruitport Middle School
Mona Shores High School
Muskegon Community College - Environmental Science
Muskegon Lake Monitoring
Muskegon Lakeshore Chamber - Muskegon in Focus
Nelson Neighborhood Improvement Association

Ottawa
Grand Haven Christian
Spring Lake Intermediate School

GVSU
GVSU Honors College Design Thinking Course
GVSU Provost Group

Various
American Association of Physics Teachers
Extension Disaster Education Network (EDEN) Group
Krakow Economists group
MI Online School
Mid-Michigan Watershed Connections teacher group
Joint Aquatic Sciences Meeting (JASM) post conference field trip

Groups using the *D.J. Angus* in 2022

Allegan
Allegan High School

Calhoun
Battle Creek Academy
GVSU ExCEL Summer Camp - Battle Creek Central High School

Kalamazoo
Providence Christian School
St. Augustine
Western Michigan University - Hydro Field Camp

Kent
Byron Center Charter, 8th
Calvin University - Geology, Geography, and Environment Department
Economicology
Grand Rapids Montessori
GVSU/Kent Career Tech Center High School
Holy Trinity
Kelloggsville High School
LIFE Co-op Homeschool
Plymouth Christian School - Chemistry Class
Potter's House - Environmental Science HS
St. Mary's Visitation
St. Paul the Apostle, 7th grade
Tri-Unity Christian High School Chemistry
West Michigan Academy of Environmental Science

Muskegon
Baker College of Nursing
Fruitport Middle School

Newaygo
Hesperia High School

Ottawa
Allendale, 4th grade
Jenison ACT
St. John's Lutheran

GVSU
GVSU - EDI631
GVSU - Geology
GVSU BIO107 - Great Lakes and Other Water Resources
GVSU BIO362 - Biology and Diversity of Fishes, Fish Trawl
GVSU HNR151-152 - Making Waves

Various
Citizen group/adults

Detailed Listing of Outreach and Education Events during the 2022 Season

D.J. Angus

Date	Group Name	Instructor	County	Number Carried onboard	Purpose of Trip	High School	Middle School	Elem School	GVSU Students	Adults	Visitors (dockside)	Total (onboard and dockside)
4/18/22	GVSU/Kent Career Tech Center High School	Russel Wallsteadt	Kent	17	Education	15				2		17
4/19/22	Fruitport Middle School	Dina Woodward	Muskegon	22	Education		20			2		22
4/19/22	Fruitport Middle School	Dina Woodward	Muskegon	22	Education		20			2		22
4/21/22	Fruitport Middle School	Dina Woodward	Muskegon	23	Education		21			2		23
4/21/22	Fruitport Middle School	Dina Woodward	Muskegon	23	Education		21			2		23
4/22/22	GVSU/Kent Career Tech Center High School	Russel Wallsteadt	Kent	17	Education	15				2		17
4/22/22	Citizen group/adults	Jessica Gregory	Various	15	Education					15		15
4/26/22	Fruitport Middle School	Dina Woodward	Muskegon	24	Education		22			2		24
4/26/22	Fruitport Middle School	Dina Woodward	Muskegon	25	Education		23			2		25
4/27/22	Tri-Unity Christian High School Chemistry	Jessica Quinn	Kent	16	Education		12			4		16
4/28/22	Fruitport Middle School	Dina Woodward	Muskegon	23	Education		21			2		23
4/28/22	Fruitport Middle School	Dina Woodward	Muskegon	22	Education		20			2		22
4/29/22	Grand Rapids Montessori	Joe Uznarski	Kent	21	Education		19			2		21
4/29/22	Grand Rapids Montessori	Joe Uznarski	Kent	12	Education		9			3		12
5/2/22	Potter's House - Environmental Science HS	Lucero Solis	Kent	20	Education	18				2		20
5/2/22	St. Mary's	Amy Giroux	Kent	23	Education		21			2		23

Date	Group Name	Instructor	County	Number Carried onboard	Purpose of Trip	High School	Middle School	Elem School	GVSU Students	Adults	Visitors (dockside)	Total (onboard and dockside)
5/3/22	St. Mary's	Sheri Jeffers	Kent	19	Education		17			2		19
5/3/22	St. Mary's	Amy Giroux	Kent	16	Education		14			2		16
5/5/22	St. Augustine	Tom Maihofer	Kalamazoo	17	Education		16			1		17
5/5/22	St. Augustine	Tom Maihofer	Kalamazoo	17	Education		16			1		17
5/6/22	St. John's Lutheran	Tamara Zevalkink	Ottawa	8	Education		7			1		8
5/9/22	Kelloggsville High School	John Linker	Kent	8	Education	6				2		8
5/10/22	Kelloggsville High School	John Linker	Kent	9	Education	7				2		9
5/11/22	Kelloggsville High School	John Linker	Kent	21	Education	17				4		21
5/12/22	Allendale, 4th grade	Lindsay Olsen	Ottawa	26	Education			24		2		26
5/16/22	Allendale, 4th grade	Lindsay Olsen	Ottawa	24	Education			22		2		24
5/17/22	Allegan High School	Cindy Eichbauer	Allegan	21	Education			19		2		21
5/18/22	Allendale, 4th grade	Lindsay Olsen	Ottawa	24	Education			22		2		24
5/19/22	Allendale, 4th grade	Lindsay Olsen	Ottawa	24	Education			22		2		24
5/20/22	Economicology	Michael Boosamra	Kent	26	Education		24			2		26
5/23/22	Allendale, 4th grade	Lindsay Olsen	Ottawa	25	Education			23		2		25
5/24/22	St. Paul the Apostle, 7th grade	Chelsea Day	Kent	19	Education		16			3		19
5/25/22	Allendale, 4th grade	Lindsay Olsen	Ottawa	26	Education			24		2		26
5/27/22	Allendale, 4th grade	Lindsay Olsen	Ottawa	24	Education			22		2		24
5/31/22	Allendale, 4th grade	Lindsay Olsen	Ottawa	24	Education			23		1		24
6/3/22	Byron Center Charter, 8th	Lisa Stowers	Kent	26	Education		24			2		26

Date	Group Name	Instructor	County	Number Carried onboard	Purpose of Trip	High School	Middle School	Elem School	GVSU Students	Adults	Visitors (dockside)	Total (onboard and dockside)
6/15/22	GVSU ExCEL Summer Camp - Battle Creek Central High School	Kristy Martin	Calhoun	15	Education	11				4		15
6/15/22	GVSU ExCEL Summer Camp - Battle Creek Central High School	Kristy Martin	Calhoun	24	Education	19				5		24
7/26/22	GVSU - EDI631	Ellen Schiller	Ottawa	16	Education				15	1		16
8/3/22	Western Michigan University - Hydro Field Camp	Chanho Park	Kalamazoo	14	Education					14		14
8/3/22	Western Michigan University - Hydro Field Camp	Garrett Link	Kalamazoo	18	Education					18		18
8/31/22	Battle Creek Academy	Barbara Stowell	Calhoun	13	Education		10			3		13
9/10/22	GVSU - Geology	Peter Riemersma	Ottawa	17	Education				16	1		17
9/10/22	GVSU - Geology	Peter Riemersma	Ottawa	18	Education				17	1		18
9/15/22	Providence Christian School	Tom Kinkel	Kalamazoo	21	Education		15			6		21
9/17/22	GVSU - Geology	Peter Riemersma	Ottawa	14	Education				13	1		14
9/17/22	GVSU - Geology	Peter Riemersma	Ottawa	22	Education				21	1		22
9/19/22	GVSU BIO107 - Great Lakes and Other Water Resources	Erin McNally-Goward	Ottawa	20	Education				19	1		20
9/19/22	GVSU BIO107 - Great Lakes and Other Water Resources	Erin McNally-Goward	Ottawa	19	Education				18	1		19
9/22/22	Calvin University - Geology, Geography, and Environment Department	Melinda Higley	Kent	10	Education					10		10

Date	Group Name	Instructor	County	Number Carried onboard	Purpose of Trip	High School	Middle School	Elem School	GVSU Students	Adults	Visitors (dockside)	Total (onboard and dockside)
9/23/22	GVSU - Geology	Peter Riemersma	Ottawa	18	Education				17	1		18
9/23/22	Baker College of Nursing	Angela Johnson	Muskegon	11	Education					11		11
9/24/22	GVSU - Geology	Carbin Ebeling	Ottawa	12	Education				11	1		12
9/24/22	GVSU - Geology	Carbin Ebeling	Ottawa	20	Education				19	1		20
9/26/22	GVSU BIO107 - Great Lakes and Other Water Resources	Erin McNally-Goward	Ottawa	18	Education				16	2		18
9/26/22	GVSU BIO107 - Great Lakes and Other Water Resources	Erin McNally-Goward	Ottawa	16	Education				15	1		16
9/29/22	Hesperia High School	Susan Morris	Newaygo	17	Education	15				2		17
10/1/22	GVSU - Geology	Peter Riemersma	Ottawa	11	Education				10	1		11
10/1/22	GVSU - Geology	Peter Riemersma	Ottawa	20	Education				19	1		20
10/3/22	Jenison ACT	Julie Clark	Ottawa	23	Education			18		5		23
10/4/22	Jenison ACT	Julie Clark	Ottawa	21	Education			15		6		21
10/4/22	GVSU HNR151-152 - Making Waves	Peter Wampler and Eric Snyder	Ottawa	26	Education				24	2		26
10/7/22	LIFE Co-op Homeschool	Melissa Smith	Kent	28	Education	23				5		28
10/7/22	Holy Trinity	Jeff Readwin	Kent	14	Education		8			6		14
10/14/22	Jenison ACT	Julie Clark	Ottawa	26	Education			24		2		26
10/17/22	West Michigan Academy of Environmental Science	Hunter Klaus	Kent	12	Education		10			2		12
10/18/22	West Michigan Academy of Environmental Science	Hunter Klaus	Kent	15	Education		12			3		15

Date	Group Name	Instructor	County	Number Carried onboard	Purpose of Trip	High School	Middle School	Elem School	GVSU Students	Adults	Visitors (dockside)	Total (onboard and dockside)
10/19/22	West Michigan Academy of Environmental Science	Hunter Klaus	Kent	17	Education		14			3		17
10/20/22	GVSU BIO362 - Biology and Diversity of Fishes, Fish Trawl	Carl Ruetz	Ottawa	14	Education				13	1		14
10/20/22	Plymouth Christian School - Chemistry Class	Rodney Van Lagen	Kent	22	Education	20				2		22
			Total	**1331**	**0**	**166**	**432**	**258**	**263**	**212**	**0**	**1331**

W.G. Jackson

Date	Group Name	Instructor	County	Number Carried onboard	Purpose of Trip	High School	Middle School	Elem School	GVSU Students	Adults	Visitors (dockside)	Total (onboard and dockside)
5/9/22	Economicology	Michael Boosamra	Kent	26	Education		23			3		26
5/10/22	Rockford Christian	Phil Warners	Kent	20	Education		16			4		20
5/11/22	Muskegon Lake Monitoring	Mike Hassett	Muskegon	8	Research				6	2		8
5/13/22	Holy Trinity	Kate Jackson	Kent	23	Education		18			5		23
5/17/22	Calvary Christian	Shannon Tyler	Muskegon	19	Education		16			3		19
5/18/22	Ingham Intermediate School District	Toby West	Ingham	26	Education	22				4		26
5/19/22	Assumption of the Blessed Virgin Mary	July Mattioli	Kent	23	Education			19		4		23
5/19/22	Assumption of the Blessed Virgin Mary	July Mattioli	Kent	23	Education			19		4		23
5/20/22	Grand Haven Christian	Bob Koning	Ottawa	33	Education			28		5		33
5/21/22	Joint Aquatic Sciences Meeting (JASM)	Al Steinman	Muskegon	10	Education					10		10
5/21/22	African Center for Aquatic Research and Education (ACARE)'s African Women in Science group	Stephanie Smith	International	9	Education					9		9
5/23/22	Murray Lake Elementary School	Stuart Kohl	Kent	28	Education			24		4		28
5/24/22	Murray Lake Elementary School	Stuart Kohl	Kent	25	Education			20		5		25
5/25/22	Murray Lake Elementary School	Stuart Kohl	Kent	28	Education			23		5		28

Date	Group Name	Instructor	County	Number Carried onboard	Purpose of Trip	High School	Middle School	Elem School	GVSU Students	Adults	Visitors (dockside)	Total (onboard and dockside)
5/26/22	Alto Elementary	Rachel Millhisler	Kent	26	Education			24		2		26
5/31/22	Alto Elementary	Rachel Millhisler	Kent	26	Education			24		2		26
6/1/22	Alto Elementary	Rachel Millhisler	Kent	23	Education			21		2		23
6/8/22	Jefferson Elementary	Jenny Janetzke	Ionia	28	Education			23		5		28
6/8/22	Jefferson Elementary	Jenny Janetzke	Ionia	23	Education			19		4		23
6/10/22	MI Online School	Amy Sterling	Various	6	Education		3			3		6
6/15/22	Muskegon Community College - Environmental Science	Matt Cooper	Muskegon	16	Education					16		16
6/28/22	John Ball Zoo staff visit to AWRI	Al Steinman	Kent	12	Meeting					12		12
6/30/22	Nelson Neighborhood Improvement Association	Paul Kendra	Muskegon	25	Education					25		25
7/6/22	GVSU - Master of Public Health (PH520)	Derick Chia	Kent	21	Education				20	1		21
7/9/22	American Association of Physics Teachers	Brad Ambrose	Various	18	Education					18		18
7/13/22	Muskegon Lake Monitoring	Mike Hassett	Muskegon	8	Research				6	2		8
7/15/22	STEM Greenhouse summer camp	Keli Christopher	Kent	16	Education		11			5		16
7/15/22	STEM Greenhouse summer camp	Keli Christopher	Kent	15	Education		13			2		15
7/15/22	STEM Greenhouse summer camp	Keli Christopher	Kent	16	Education		14			2		16

Date	Group Name	Instructor	County	Number Carried onboard	Purpose of Trip	High School	Middle School	Elem School	GVSU Students	Adults	Visitors (dockside)	Total (onboard and dockside)
7/27/22	Mid-Michigan Watershed Connections teacher group	Dave Chapman	Various	13	Education					13		13
8/2/22	Club 188 / Mount Zion Church of God in Christ summer program	Janie Brooks-Davis	Muskegon	20	Education		16			4		20
8/16/22	EGLE Plankton/Algae Course	Scott Schmidt	Ingham	21	Education					21		21
8/18/22	Boys and Girls Club of Muskegon	Kyle Hart	Muskegon	21	Education			16		5		21
8/18/22	GVSU Provost Group	Al Steinman	Ottawa	20	Meeting					20		20
8/26/22	Senator Gary Peters visit	Al Steinman	Ingham	14	Meeting					14		14
9/6/22	Spring Lake Intermediate School	Garth Trask	Ottawa	25	Education		23			2		25
9/7/22	Spring Lake Intermediate School	Garth Trask	Ottawa	27	Education		25			2		27
9/8/22	Grace Christian Academy	James Bazen	Kent	26	Education	24				2		26
9/8/22	Krakow Economists group	Sonia Dalmia	Various	23	Education					23		23
9/9/22	Spring Lake Intermediate School	Garth Trask	Ottawa	26	Education		25			1		26
9/12/22	East Grand Rapids Middle School	Becky Martin	Kent	27	Education		26			1		27
9/12/22	East Grand Rapids Middle School	Becky Martin	Kent	26	Education		24			2		26
9/13/22	East Grand Rapids Middle School	Becky Martin	Kent	23	Education		22			1		23
9/13/22	East Grand Rapids Middle School	Becky Martin	Kent	24	Education		20			4		24

Date	Group Name	Instructor	County	Number Carried onboard	Purpose of Trip	High School	Middle School	Elem School	GVSU Students	Adults	Visitors (dockside)	Total (onboard and dockside)
9/14/22	East Grand Rapids Middle School	Becky Martin	Kent	26	Education		23			3		26
9/14/22	East Grand Rapids Middle School	Becky Martin	Kent	25	Education		23			2		25
9/14/22	GVSU Honors College Design Thinking Course	Paul Lane	Ottawa	26	Education					0	26	26
9/15/22	East Grand Rapids Middle School	Becky Martin	Kent	23	Education		22			1		23
9/15/22	East Grand Rapids Middle School	Becky Martin	Kent	27	Education		24			3		27
9/16/22	East Grand Rapids Middle School	Becky Martin	Kent	30	Education		26			4		30
9/19/22	Eastern Middle School	Shelby Horne	Kent	27	Education		24			3		27
9/19/22	Eastern Middle School	Shelby Horne	Kent	26	Education		23			3		26
9/20/22	Spring Lake Intermediate School	Garth Trask	Ottawa	26	Education		24			2		26
9/21/22	Spring Lake Intermediate School	Garth Trask	Ottawa	26	Education		23			3		26
9/22/22	Eastern Middle School	Shelby Horne	Kent	27	Education		22			5		27
9/22/22	Eastern Middle School	Shelby Horne	Kent	28	Education		25			3		28
9/23/22	Saugatuck High School - AP Environmental Science	Brad Smit	Allegan	27	Education	25				2		27
9/26/22	Eastern Middle School	Shelby Horne	Kent	24	Education		21			3		24
9/26/22	Eastern Middle School	Shelby Horne	Kent	27	Education		24			3		27
9/27/22	Mona Shores High School	Mary Poort	Muskegon	18	Education	16				2		18

Date	Group Name	Instructor	County	Number Carried onboard	Purpose of Trip	High School	Middle School	Elem School	GVSU Students	Adults	Visitors (dockside)	Total (onboard and dockside)
9/28/22	Muskegon Lake Monitoring	Mike Hassett	Muskegon	8	Research				6	2		8
9/29/22	Eastern Middle School	Shelby Horne	Kent	25	Education		23			2		25
9/29/22	Muskegon Lakeshore Chamber - Muskegon in Focus	Cindy Larsen	Muskegon	21	Education					21		21
9/30/22	West Oakview Elementary School	Colleen Heyboer	Kent	25	Education			23		2		25
9/30/22	West Oakview Elementary School	Colleen Heyboer	Kent	26	Education			23		3		26
10/3/22	Okemos High School	Laura Bell	Ingham	14	Education	11				3		14
10/4/22	Spring Lake Intermediate School	Garth Trask	Ottawa	25	Education			24		1		25
10/5/22	Spring Lake Intermediate School	Garth Trask	Ottawa	22	Education			21		1		22
10/6/22	Crestwood Middle School	Bobbie Fletcher	Kent	27	Education		25			2		27
10/6/22	Crestwood Middle School	Bobbie Fletcher	Kent	27	Education		25			2		27
10/7/22	Fruitport Middle School	Dina Woodward	Muskegon	28	Education		26			2		28
10/7/22	Fruitport Middle School	Dina Woodward	Muskegon	26	Education		24			2		26
10/8/22	Jack and Jill - Grand Rapids Chapter	Kania McGee	Kent	10	Education		6			4		10
10/10/22	Fruitport Middle School	Dina Woodward	Muskegon	21	Education		19			2		21
10/10/22	Fruitport Middle School	Dina Woodward	Muskegon	20	Education		19			1		20
Date	**Group Name**	**Instructor**	**County**	**Number Carried onboard**	**Purpose of Trip**	**High School**	**Middle School**	**Elem School**	**GVSU Students**	**Adults**	**Visitors (dockside)**	**Total (onboard and dockside)**

10/11/22	Grandville Public Schools - IMAGE program	Kyle Anderson	Kent	16	Education			11		5		16
10/11/22	Extension Disaster Education Network (EDEN) Group	Wade Syers	Various	24	Education					24		24
10/12/22	Grandville Public Schools - IMAGE program	Kyle Anderson	Kent	28	Education			20		8		28
10/13/22	Fruitport Middle School	Dina Woodward	Muskegon	27	Education		25			2		27
10/13/22	Fruitport Middle School	Dina Woodward	Muskegon	27	Education		24			3		27
10/14/22	Fruitport Middle School	Dina Woodward	Muskegon	28	Education		26			2		28
10/14/22	Fruitport Middle School	Dina Woodward	Muskegon	29	Education		27			2		29
10/20/22	Muskegon Community College - Environmental Science	Matt Cooper	Muskegon	16	Education					16		16
			Total	**1849**		**98**	**868**	**382**	**38**	**437**	**26**	**1849**

Evaluation Data

The leader of the group is asked to fill out a short evaluation of the trip before disembarking the vessel. The evaluation forms for the vessel program ask a series of Yes/No questions that vary by age group (see survey below). All of the evaluation forms for 2022 answered “Yes” to every yes/no question; therefore, an analysis of that data is not provided here. Participants filling out the evaluation form also have an opportunity to provide open-ended qualitative feedback via comments, all of which are provided below.

This year, a new question was added: “What aspect of the cruise resonated the most? How could you bring it back to your classroom?” This directed request for comments elicited more helpful and actionable feedback about our curriculum. Responses will help us to emphasize the elements of trips that are most impactful, as well as develop resources to support learning extensions that teachers are interested in.

By far, the hands-on activities resonated the most, as well as the application of what students were learning to the real world. Clearly, our program plays an important role in helping science come alive for students, as they get to actively participate as scientists as well as understand how science is important outside of their classroom experiences. Food webs and viewing plankton under the microscopes also came up frequently as subject matter highlights. The experience of being on the lakes, a perspective not many students have previously had, also was noted as very impactful.

Regarding taking what they had learned back to their classroom, many teachers noted connections that they would be able to continue to make with their regular curriculum, using the vessel experience as a touch point and reference for the rest of the school year. Some noted that this could include interdisciplinary applications outside their science classes, such as English and Language Arts applications of learning what the prefixes phyto- and zoo- mean. Several teachers expressed interest in continuing to analyze the data their students collected on board. Others noted that they would like to conduct tests and observations in lakes and streams at or near their schools and compare these observations to their activities on the vessels. These are areas that AWRI could support by providing resources, recommendations, or lesson plans that teachers could use after a cruise to deepen student learning.

In the general comments, visitors noticed and appreciated the teaching staff’s teamwork, expertise, patience, and adaptability in working with students under a variety of conditions.

Teacher's Evaluation of AWRI Educational Cruises

Fourth Grade:

1. Did the cruise provide your students with an opportunity to participate in the process of inquiry (generating questions, making observations, taking measurements, and creating charts/graphs)?
Yes___ No____

2. Did the instructors engage your students in analyzing data and using information to answer questions, make comparisons, and draw conclusions? Yes___ No____

3. While participating in the field trip, were your students taught how humans and other organisms can affect the balance of the natural world? Yes___ No____

4. Were your students provided with an opportunity to examine living organisms and learn about their survival and how they are related as parts of a fresh water food web? Yes___ No____

5. On a scale of 1 (poor) to 4 (very good), how would you rate this learning opportunity for your students?

6. What aspect of the cruise resonated the most? How could you bring it back to your classroom?

Other Comments:

Fifth/Sixth/Seventh/Eighth Grade:

1. Did the cruise provide your students with an opportunity to participate in the process of inquiry (generating questions, making observations, taking measurements, and creating charts/graphs)?
Yes___ No___

2. Did the instructors engage your students in analyzing data and using information to answer questions, make comparisons, and draw conclusions? Yes___ No___

3. While participating in the field trip, were your students taught how humans and other organisms can affect the balance of the natural world and given an opportunity to predict the consequences of pollution and other human activities that have an impact on the aquatic environment? Yes___ No___

4. Did your students have an opportunity to learn about the flow of water in the Great Lakes watershed and how water quality affects the survival of the populations, communities and ecosystems that live in the Great Lakes environment? Yes___ No___

5. On a scale of 1 (poor) to 4 (very good), how would you rate this learning opportunity for your students?

6. What aspect of the cruise resonated the most? How could you bring it back to your classroom?

Other Comments:

High School:

1. Did the cruise provide your students with an opportunity to participate in the process of scientific inquiry (generating questions, conducting investigations, analyzing data, making comparisons, and drawing conclusions)? Yes___ No___

2. Did the instructors engage your students in a discussion of human impact on the aquatic environment and the societal issues involved in managing the Great Lakes ecosystem? Yes___ No___

3. While participating in the field trip, did your students learn about the populations and communities that make up the Great Lakes ecosystem and the relationships between the organisms that make up aquatic food webs in the freshwater environment? Yes___ No___

4. Did your students have an opportunity to learn about water quality and the abiotic factors that influence the survival of species in the aquatic environment? Yes___ No ___

5. On a scale of 1 (poor) to 4 (very good), how would you rate this learning opportunity for your students?

6. What aspect of the cruise resonated the most? How could you bring it back to your classroom?

Other Comments:

Higher Education:

1. Did the cruise provide participants with an opportunity to participate in the process of scientific inquiry (generating questions, conducting investigations, analyzing data, making comparisons, and drawing conclusions)? Yes___ No___

2. Did the instructors engage participants in a discussion of human impact on the aquatic environment and the societal issues involved in managing the Great Lakes ecosystem? Yes___ No___

3. Was this experience valuable to the learning goals of the participants? Yes___ No___

4. What other topics or experiences would you like participants to have on their cruise?

5. On a scale of 1 (poor) to 4 (very good), how would you rate this learning opportunity for your students?

Other Comments:

All Comments from Evaluations

What aspect of the cruise resonated the most? How could you bring it back to your classroom?

- *Elementary School*
  - Doing multiple trials - our impact on the environment with turbidity, types of lakes
  - I like the idea of having the students do further research on the species invading the lakes. Also, further discussion on the differences of water quality between the two lakes.
  - Being scientists and that process. [We can help them] bring that attitude and process to all they do
  - Scientific inquiry and "right here" science
  - They seemed interested in invasive species. We could talk more about this in the future (photo vs zoo prefixes - sci/ELA connection)
  - I liked how interactive it was for the kids. [We could do] more hands-on activities and experiments
  - The hands-on activities were great! The students loved it
  - The measurements
  - Enthusiasm for our Lakes, engaging the students. We will be able to use the data to use as a real-life experience related to our lessons
- *Middle School*
  - Students appreciate the hands-on experience for the whole day.
  - Hands-on experience, reviewing types of lakes (3), extending the lessons with data sheets
  - They loved seeing the different live organisms on the TV (microscope)
  - Using data and evidence to support concepts being taught in class
  - We learn about the three categories of water quality, and this trip always allows them to make the "aha!" connection between chemical, biological, and physical parameters as they collect and analyze that data.
  - Students love being the ones to run all the labs on the boat. We will continue trusting students with this role back at school.
  - This is a great starting point for discussions about environmental sustainability
  - Lake characteristics/OME and how to identify. Data collection so helpful
  - The hands-on learning experience resonates so well with all my students. They talk about this all year! Thank you.
  - How to protect the Great Lakes ecosystems
  - Protecting our freshwater systems!
  - It tied perfectly to food webs in an ecosystem which is what we are currently studying. Love the independence for my students. I'd like to compare data from our group that came beg/mid/end of September
  - Hands-on
  - Hands-on data collection. We will use the microscopes to identify more plankton. Data analysis will lead to class discussions
  - Amazing hands-on activities!
  - Students were thrilled with hands-on activities and the opportunity to use real scientific equipment. Our science unit will be greatly enriched by the experience.
  - Thank you for offering this hands-on opportunity to our learners. Our geology unit later in the year will revisit many of these ideas.

- We are currently studying the five themes of Geography, which ties directly into what was taught today!
- Information about a food web, and invasive species
- Hands-on activities, make real world connections
- The amount of science the students were able to participate in. This will fit in our life science unit perfectly.
- Hands-on science opportunity, learning about our home state/local environment (Place-based)
- Giving the students a chance to be a citizen scientist. I love how you introduce them to pH, turbidity, and secchi disks.
- The hands-on was great!
- Hands-on experience and analysis of measurements - not just numbers
- Our kids loved learning through samples, and they were able to practice learning as a team, which is something we work on a lot at Club
- So much info about our area that we can discuss
- We will debrief with the data and water quality. Human impact on the water resources
- All the testing! We are going to do some of these tests again soon.
- Food web and chain, flow of energy, measurement, observations, invasives, importance of accurate data collection
- Lots of hands-on data analysis, we'll do more of this. The kids loved actually observing and interacting with the science
- They love the hands-on experiments. We will explore the lake right outside our school - Murray Lake.
- Kids engaged in good, real science
- The changes in the lake over time
- Hands-on opportunities for students. We will compare to our local lake
- The data collection with tools - we will replicate some of this next week in Reed's Lake
- It was great to see the students referred to as scientists and be able to complete hands-on experiments!
- The discussion of invasive species will be especially important to our ecosystem study this year. The discussion and study of healthy water is a great addition.
- This experience helped us fulfill our efforts to give our youth hands-on science/academic experiences
- It is cool for them to learn about what scientists do
- We just learned the scientific method and why we take multiple samples
- Relevant and engaging activities with real life applications
- The connection of chemistry with life science - they complement one another! We can look more at Lake Michigan ecosystems specifically
- The kids loved being a part of the tests. They used their knowledge from the classroom

- *High School*
  - Looking at the plankton and discussing how invasives have changed the classroom. Will look at the plankton tomorrow in classroom (microscopes)
  - Lots of real world, relevant, and important information. Great hands-on experience for students
  - The experience on Lake Michigan collecting and analyzing data

- Cellular Life
- Liked how you incorporated all the kids with doing testing.
- Exposure for students to science activities in a real-life setting. Great experience for our online students!
- Data is great and we just learned about eu, oligo, and mesotrophic lakes!
- Since we did it for the chemistry class, the pH, dissolved oxygen, phosphate, nitrate tests will be brought back into classroom. The real-world applications show students that chemistry exists in the real world

What other topics or experiences would you like participants to have on their cruise? *(Higher education only)*

- More time to benefit from your expertise!
- Instructors did an excellent job presenting a wide range of topics vital to scientific inquiry, necessary to Lake Michigan and waterways of our area
- Love the topics. They connect well to the students' lecture material
- Nothing different - it was amazing
- All the stations were set up nicely. The weather conditions limited our time only in Spring Lake. However, everyone enjoyed spending time on the boat.
- Temp/oxygen profiles

General Comments:

- *Elementary School*
  - There have been changes from previous years and I love it! Students were very engaged all the time!
  - Thank you so much for enthusiastically bringing science down to the level of my 10-year-olds
  - I LOVE this trip. it is always such a wonderful experience for all the kids
  - Steve's enthusiasm and humor
  - Thank you!
- *Middle School*
  - I appreciate you being flexible with the waves.
  - Very helpful staff. Thank you!
  - Ann and Bob were a "dream team" - they make it an exceptional experience for all of us, even on a stormy day. Thank you for having us again.
  - Awesome work today! Thank you for interacting with our students as if they are the scientists!
  - The instructors explained things well and engaged kids easily
  - Absolutely informative! Thank you!
  - Wonderful trip, thank you!
  - Everything was engaging. Crew was great.
  - Thank you!
  - Thank you for being so patient and flexible with our group
  - Great, as usual!
  - The only feedback I would give is to maybe use a microphone at the beginning because it was difficult to hear the speaker. Thank you!

    - Time was our biggest issue. The staff and crew were amazing! We just ran out of time. Short [cruise]
    - This was a shorter cruise, but it was a good amount of time for those students which have some learning challenges
    - Wish "hero" had more direct involvement
    - Thank you so much! Our kids had fun and the staff was helping them stay engaged and feel important!
    - Better sound system today
    - The staff was well prepared and wonderful with the students and provided a great outdoor learning experience. Thank you!
    - Hands-on, helpful, patient instructors
    - Great trip. Maybe make sure to refill the water/cups on sunny days. Also, I had a student talking to a friend during the introduction, and Jamie called him out - fantastic! I think it's great that you make them take it seriously/stay on task. Thank you!
    - Great trip. The staff were amazing with middle school students!
    - Thank you - the crew was wonderful!
    - Excellent instruction! A little fast for their knowledge level but with written instructions they were great for us.
    - Good program
    - This is so cool. I got 3 different experiences and each one was perfect for the kids on the ship
    - We had an awesome time! Instructors did an amazing job teaching our students
    - Crew was engaging and patient
    - Biologist and Geologist were absolutely awesome. Very well done and captivated the students' attention. Thanks so much!
    - Amazing, as always! Thank you!
    - This field trip is the highlight of our year. Great learning opportunity!
- *High School*
    - This is my 20th year bringing students - highlight of my year - hope to work with you when I retire!
    - Fabulous!
    - Instructors worked together very well. Very interesting and educational. Very engaging.
- *Higher Education*
    - Always a great summary/synthesis of what we've been covering
    - All great! Fantastic educators! Great Job! Thank you!
    - Always great to get our students out on the WGJ
    - Jamie and her team did an extraordinary job with the African Women in Science Program!
    - What a terrific learning experience for our neighbors. Thank you!
    - Instructors were very knowledgeable, thorough, personable, and very good at what they do. They made studying Lake Michigan very fun and informative at the same time
    - Great cruise as always
    - This was an amazing opportunity for students to experience surface water sampling