Water Resources Outreach Education Program

2023 Research & Education Vessel Use Report

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Executive Summary

Founded in 1986, the Robert B. Annis Water Resources Institute has a mission to integrate research, education, and outreach to enhance and preserve freshwater ecosystems. The Water Resources Outreach and Education Program has been key to AWRI fulfilling that mission. The outreach program delivers a unique hands-on investigative experience to educate citizens about water, with special emphasis on educating youth. We offer experiential learning about water quality, aquatic food webs, and human impacts on water. Our ship-based research and learning laboratories connect citizens in West Michigan and across the Lake Michigan Basin, with local, regional, and global freshwater ecosystems.

During an educational cruise, participants serve as freshwater scientists, collecting data and observations about the water bodies through which they sail. Since 1986, over 192,000 people (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 2023, over 4000 visitors from 96 groups 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 2023 included: 810 elementary school students (19.6%); 1222 middle school students (29.6%); 608 high school students (14.7%); 401 GVSU students (9.7%); and 1079 adults including teachers, chaperones, other college students, groups, and the general public (26.1%). Program participants visited AWRI from Kent (54 trips), Ottawa (52), Muskegon (48), Kalamazoo (5), Ingham (4), and Newago counties (1), plus 10 other Michigan counties with 1 or 2 trips each. In addition, we welcomed one school group from Iowa, one national conference group, and two international groups. Registration on both vessels in 2023 continued to approach pre-pandemic levels, with an increase of 30% from 2022. Ridership in 2023 was 80% of 2019's ridership overall, 72% for the Angus, and 84% for the Jackson.

Going into the 2024 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 relevant science into the vessel curriculum. Challenges (internal and external) also exist that pose obstacles to realizing this potential.

Program Overview

AWRI vessel instructor Doug Haywick assists students with a plankton density test onboard the D.J. Angus.

AWRI has two research and education vessels: the *D.J. Angus* (docked in Grand Haven) and the *W.G. Jackson* (docked in Muskegon). The vessels serve as floating classrooms, providing an exceptional educational experience unique in West Michigan and rare in the broader Great Lakes region. Our ship-based learning laboratories connect people with aquatic ecosystems through experiential learning about water quality, aquatic food webs, and human impacts on water. Participants aboard an educational cruise serve as freshwater scientists, collecting data and observations about the water bodies through which they sail.

Ship-based education at GVSU dates back to 1965, when entrepreneur/inventor 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 for Grand Valley courses. In 1986, a new research vessel, the *D. J. Angus,* replaced the *Angus,* and the AWRI outreach program was established. The success of the onboard programs led to the *Making Waves in Muskegon* campaign, which raised funds to build and endow a second vessel, the *W.G. Jackson* (named after Dr. William Jackson) in 1996. With the addition of the *W.G. Jackson*, AWRI has been able to serve an even greater number of individuals through our onboard programs, as well as enhance AWRI research.

To date, there have been over 192,000 participants since the outreach program began. 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 (9%). Both vessels are used for AWRI faculty and student research projects as well as the outreach program.

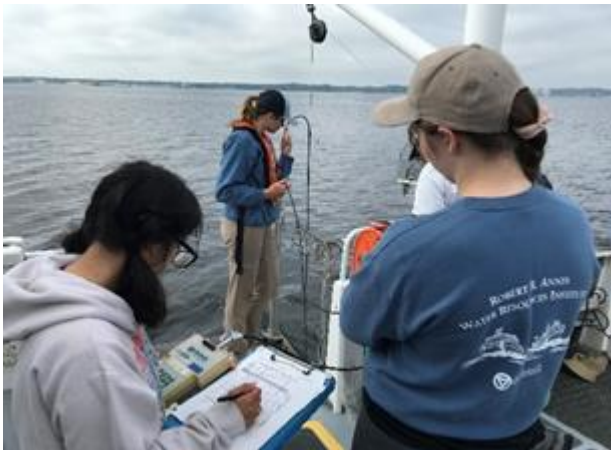
The onboard curriculum is structured around conducting water quality tests and other observations to compare the physical, biological, and chemical characteristics of Lake Michigan to smaller inland lakes and rivers. Both vessels offer the same overall trip structure and curriculum with place-based variations 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 Grand River watershed and the dynamics of smaller, shallower Spring Lake.

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

2023 Season Highlights

Research

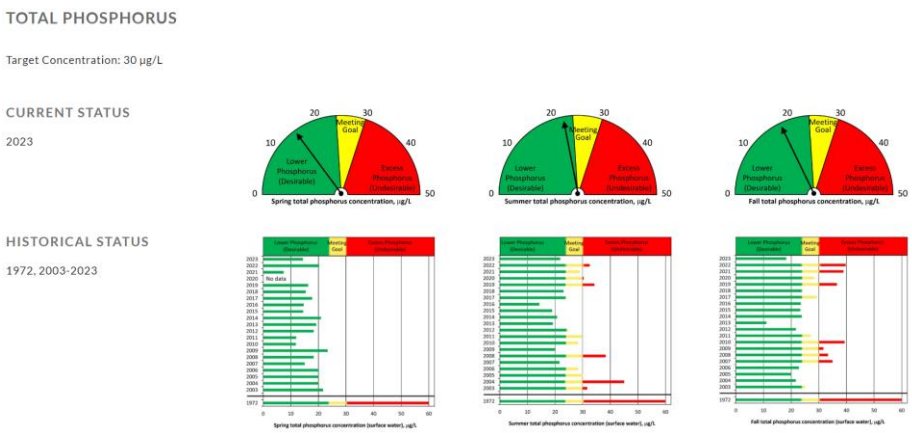
The AWRI vessels have had a long history as a platform for research projects. In the past, both the *W.G. Jackson* and *D.J. Angus* were employed to collect sediment from the bottom of Lake Michigan as part of a project funded by the National Institute of Health to study Great Lakes fungal communities. The fungi are being screened for chemicals that may destroy a range of cancer cell types, particularly pediatric cancers. More recently, the *W.G. Jackson* was used to study microplastics in Muskegon Lake.



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

The Muskegon Lake Monitoring 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). Since 2003, AWRI technicians have collect samples at six stations 3 times per year (late spring, summer, early fall). Fish monitoring is done at 4 other shallow-water sites using smaller vessels. The Muskegon Lake Water Quality Dashboard provides an easy-to-understand visual representation of lake health.

The *W.G. Jackson* also supports research in conjunction with the Muskegon Lake Observatory buoy, which has been run by Dr. Bopi Biddanda's laboratory since 2011. A review of the prior year's time-series water quality data and making comparisons to the present day 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).



Snapshot of Total Phosphorus conditions from the Muskegon Lake Water Quality Dashboard

Outreach & Education

Program Attendance

In 2023, we offered more learning opportunities than we have since pre-pandemic times. A total of 4135 people on 201 trips participated in vessel programming this year, a 30% increase from 2022 (Table 3). Registration on both vessels in 2023 continued to approach pre-pandemic levels, at 80% of 2019's attendance overall, 72% for the Angus, and 84% for the Jackson (Figure 1).

Students conduct dissolved oxygen tests in the lab on the D.J. Angus.

In 2023, middle school trips (6-8 grade) continued to account for the largest proportion of vessel program participants: 28% on both vessels; 27% on the *D.J. Angus* and 29% on the *W.G. Jackson* (Figure 2). This is consistent with use trends on the vessels since the early 2000s (Figure 1). Public, private, charter, home schools, and parochial schools are all regular users of the vessels. Most students participate in the vessel program through class field trips; however, some students participate through out-of-school time programs and summer camps.

The vessel experience has long been a part of the curriculum for some GVSU courses, with over 18,000 GVSU students and staff on both vessels since 1986. 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.

The GVSU courses using the vessels in 2023 were:

Assistant Science Instructor Meryl Luoma-Mannisto views a benthic macroinvertebrate sample with a student on the W.G. Jackson.

- Biology 107 (Great Lakes and Other Water Resources, Erin McNally Goward)
- Biology 215 (Ecology, Eric Snyder)
- Biology 540 (Limnology, Meg Woller-Skar)
- Honors College Biology (Water for a Changing World, Eric Snyder)
- Biology 362 (Biology and Diversity of Fishes, Carl Ruetz)
- Education 631 (Teaching Science K-8, Ellen Schiller)
- Geology 103, 105, and 430 (Living with the Great Lakes, Peter Riemersma)
- Public Health 520 (Environmental Health, Azizur Molla)

GVSU's ExCEL Summer Camp as well as the newly formed Fisheries and Aquatic Sciences Club also utilized the vessels. The GVSU Development Office employed the *W.G. Jackson* for community outreach, and two GVSU administrative offices used the vessel during staff training.

Beyond GVSU, courses from Calvin University, Grand Rapids Community College, Western Michigan University, and the Baker College of Nursing also participated in cruises on the vessels.

A student assists Deckhand Tim Halloran with collecting water samples of Spring Lake on the D.J. Angus.

For other adult visitors, community groups (such as neighborhood associations, churches, and civic groups) also utilized the vessel, a mix of new and returning groups. A national conference (National Educational Telecommunications Association [NETA] Conference & Corporation for Public Broadcasting Public Media Thought Leader Forum) brought its attendees onboard. Conference inquiries for cruises have increased as conferences have continued to ramp up in the wake of the COVID-19 pandemic.

The service areas differ somewhat between the two vessels (Figure 4 and 5). In 2023, we saw more groups from more counties overall (17 Michigan counties compared to 9 in 2022). In addition to Michigan groups, we served one school from Iowa, one national group, and two international groups.

The outreach program is working to understand the proportion of new versus returning groups to the vessel program. This year, a series of questions were added to the vessels' participant list form:

Is this your group's first time on our vessels? (Yes/No)
If NO, how many years have you visited? (fill in the blank)
If YES, how did you hear about us? (fill in the blank)


Attendees from the 2023 NETA conference on the W.G Jackson.

Though not all groups responded to these questions, we were able to get a sense of the past experience that many groups have had with the program (Tables 7 and 8). Among returning users, the number of years participating in the vessel program ranged from two to over twenty. Word of mouth (current and former AWRI staff, GVSU faculty, and fellow teachers) along with internet searching seem to be primary ways that new users discovered our programming.

Partnerships and Support

We experienced particular growth this year in summer activity and reaching non-traditional groups like camps and homeschool co-ops. These groups included scout troops, 4-H clubs, and the Boys & Girls Club of Muskegon. In the future, more partnerships with informal learning programs, such as these, have great potential to reach additional students when school resources are stretched, and to reach students of color and other populations historically underserved by science education.

Thanks to the vessel endowments, the outreach program already provides cruises at a heavily subsidized rate to groups using the vessels. However, transportation can be a financial and logistical barrier. In late 2022, the Lakeshore Museum received funding from the Howmet Foundation to help cover transportation costs for Muskegon County school groups traveling to science, technology, engineering, arts, and math (STEAM) field trips in Muskegon. The AWRI outreach program was invited to partner with the Museum along with several other organizations including the Hackley Public Library, the Lakeshore Fab Lab at Muskegon Community College, the Muskegon Museum of Art, and the Silversides Museum. AWRI provided this transportation funding support to 10 Muskegon County schools who participated in our outreach program in 2023 (Ravenna Middle School and High School, Three Oaks Public, Muskegon Heights MLK Elementary, Innovative Learning Center, Mona Shores Middle School, Reeths-Puffer Elementary School and Middle School, Bunker Elementary, and Fruitport Middle School).

The vessel program staff also participated in nine West Michigan festivals and public events with an information table and opportunities to experience a version of the hands-on activities conducted onboard our cruises. This is triple our participation in public events of this kind from the 2022 outreach season. The festivals were:

- Film event: "Muskegon Lake: Avoiding an Erie Situation," West Michigan Shoreline Regional Development Commission (Muskegon, February)
- Water Pool-ooza, City of Grand Rapids Water System (Grand Rapids, March)
- Science Olympiad (Allendale, March)
- Lakeshore Earth Day Festival (Grand Haven, April),
- STEAM Along the Lakeshore, GVSU Regional Math and Science Center (Muskegon, May)
- Groundswell Project Showcase (Grand Rapids, May)
- Macatawa Water Festival (Holland, August)
- Grand River Adventure, Grand Rapids Public Museum (Grand Rapids, September)
- Energizing Our Weekend Family Fun event, GVSU Regional Math and Science Center (Allendale, November)

Science Instructors represent AWRI's outreach and education programs with a table (right) at the Macatawa Water Festival on Windmill Island in Summer 2023.

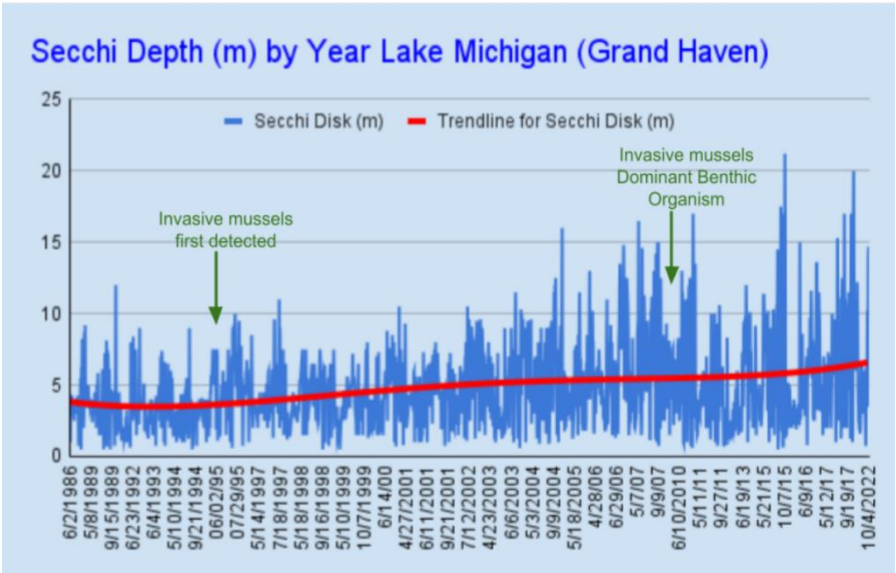
W.G. Jackson Away Trips

The W.G. Jackson *docked in Michigan City, IN in June 2023.*

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 around Lake Michigan since 1998 (Figure 5). In June 2023, the *W.G. Jackson* visited two Indiana ports on the coast of Lake Michigan – the first time the vessel has taken an away trip since 2019, due to the COVID-19 pandemic. The vessel first visited Hammond (in partnership with the Indiana Department of Environmental Management), followed by Michigan City (hosted by the Sanitary District of Michigan City). Both have hosted the *W.G. Jackson* in prior years. In addition to our standard curriculum, the cruises highlighted local stewardship and restoration activities. The tour was scheduled during Lake Michigan Coastal Awareness month, and an estimated 323 people participated in the 15 events at the two ports (12.9% of the vessel's total 2023 attendance). The cruises were well received by the hosting partners and cruise attendees in both locations. The outreach program will continue to consider away trip opportunities as budgets and staff capacity permit.

Support Materials

In 2023, the outreach staff worked on re-organizing the science data collected during our field trips. We now have two publicly available spreadsheets that contain every year of data that the vessels have gathered. The dataset can be downloaded and analyzed by our staff as well as any interested parties, such as teachers who have participated in cruises or big data research efforts. One initial graphing by a science instructor showed increasing water clarity indicated by Secchi Depths collected on the *D.J. Angus*, annotated with the timeline of the introduction of invasive mussels into Lake Michigan. Many other opportunities exist to explore changes observed over time in this long-term citizen science dataset.



Land-Based Programs

Students assist with sorting plastic and organic debris collected from Pere Marquette beach by the BeBot during a landside program.

AWRI continues to reach additional students through land-based activities on AWRI's grounds and in the R. B. Annis Educational Foundation classroom. In 2023, 32 landside programs were offered to 15 different groups, all but three of which in conjunction with trips on the *W.G. Jackson.* In all, 912 people were served through our landside programming in 2023, nearly twice as many individuals as in 2022. As with the vessel program, we continue to approach pre-pandemic levels with the landside program (in 2019, we served 1964 people through 83 events), and anticipate that participation will return to more typical levels over time.

This year, we continued to offer land-based programs fully outdoors. Moving our classroom programming outdoors was originally a COVID-19 adaptation, but we have seen immense value in the outdoor learning environment, observed improved student engagement, and received overwhelmingly positive teacher feedback. Even on challenging weather days, staff embrace opportunities presented by the elements to learn outdoors. During landside programs, students actively engage in the land/water connection of the Muskegon River watershed through interactive activities and land-based monitoring and observations. When available, we also offer service-learning opportunities to students, such as having them assist with sorting debris collected from Pere Marquette beach by the BeBot, AWRI's trash collecting drone.

The R. B. Annis Educational Foundation classroom was used in a variety of ways in 2023. For example, the Square One Foundation offered a professional development workshop for teachers on Underwater Remotely Operated Vehicles in June, utilizing the classroom as well as spare mesocosm tanks. AWRI also hosted the "Design Thinking for Social Product Innovation" course offered by the GVSU Frederick Meijer Honors College in September for the third year running.

Students explore flow speed, bank stabilization, and stream sinuosity during a stream restoration simulation activity, using runoff on AWRI's parking lot during a rainy program.

Science Instructor Lynn Knopf provides instruction to students during a landside program on AWRI's grounds.

2024 Outlook and Goals

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

Going into the 2024 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 further incorporate the most pressing science into the vessel curriculum. Challenges (internal and external) also exist that pose challenges to realizing this potential.

Opportunities & Challenges

Staffing & Personnel

Staff changes in 2023 included the hiring of two new instructors for the landside program, plus a recent GVSU alum as an assistant science instructor. This expanded our teaching capacity and our ability to meet the growing demand for our programs as attendance has increased. However, maintaining a fully staffed crew requires perennial effort. Because of the short but intensive seasons for vessel operations, as well as pay constraints, finding and keeping employees can be difficult for both instructional and vessel operations staff.

AWRI is currently in the midst of a search for its next Executive Director. Thus far, outreach and education have been clearly foregrounded as a priority for the institute as the search unfolds. This is reflected in search materials, as well as the outreach program's manager serving on the search committee at the invitation of the Provost and CLAS dean's office. Once the next director is in place, there will be opportunities to explore ways to grow the outreach program in new directions under new leadership, though there may be temporary challenges in the transition.

Diversity, Equity, Inclusion, Accessibility, and Belonging

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, this 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 of our staff is a priority.

In 2023, the outreach program staff held an internal workshop and conversation about inclusive and equitable science education, a first for the program. More conversation and training on diversity, equity, inclusion, accessibility, and belonging (DEIAB) topics will take place for the team, as we work towards a shared goal of being welcoming and accessible to all learners in our programming.

The educational programs will also continue to build relationships, and identify and remove barriers to underserved populations participating in our programming, especially among Muskegon schools. Opportunities remain to deepen our understanding of the geography and demographics of groups that are participating in the outreach program, giving us information upon which to strategically target new relationships and partnerships with schools and informal learning groups. The latter have seen particular growth on our schedule in recent years, and present unique opportunities to reach students whose schools may not have the capacity to provide them with field trip experiences.

Scientific Content and Rigor

The educational program is very fortunate to have access to 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 research questions and data into the educational experience will further distinguish our already-unique vessel program.

As the climate crisis continues to unfold, it is incumbent upon our program to make connections more explicitly between climate change and the aquatic science topics currently covered during programs. In 2021, a section was added to the Instructor Manual on climate impacts to Michigan and the Great Lakes, including a table of ways that AWRI vessel cruise observations may change due to climate change. For example, dissolved oxygen would generally be expected to decrease in a warming climate since warmer water holds less oxygen, and plankton density may increase as algal growth increase (including harmful algal blooms). Discussion of climate change could be more consistently incorporated into vessel cruises, with particular emphasis on solutions alongside the impacts.

AWRI Science Instructor Bob Myers discusses thermoclines and lake stratification with students onboard the W.G. Jackson.

Though some groups are well-prepared for their cruises and continue their learning in the classroom before and after a cruise, this is highly varied across visiting groups. Understanding that this variability will always be the case, AWRI outreach staff are continuing to consider the development of additional support materials, including optional pre- and post-cruise resources for teachers. 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.

Attendance and Transportation

The vessel schedule continues to approach but remains short of pre-pandemic levels. In 2019 and earlier, there was often a waitlist to schedule vessel trips, but this has not been the case in recent years. 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.

Budget cuts and increasing class sizes in some school districts present external challenges that impact our program's reach. As in prior years, the cost and logistics of transportation have continued to be prohibitive for some schools. In fact, busing is perhaps the biggest barrier to returning to a full, pre-pandemic schedule. The Howmet Foundation bus grant partnership helped a subset of groups by offsetting their transportation costs, but these subsidies do not address other constraints, such as bus availability and schools' day lengths. We will continue to explore additional ways that AWRI's program can expand access to our programs given the systemic issues that limit the ability of schools today to participate in field trips of all kinds, not just with our program.

A student and chaperone conduct the turbidity tube test onboard the D.J. Angus

Safety

A few minor safety incidents and near misses prompted a fresh look at safety protocols for the outreach program, both on the vessels and on land. Renewed focus was given to safe chemical handling in our labs. New safety procedures are being established for the landside program as well, given the additional safety considerations involved in outdoor learning. 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 maintenance needs and water level variations.

Program Goals

Near term

- Deliver high quality educational programs in a cost-effective manner.
- Continue enhancement of curriculum for the vessel and landside programs, with emphasis on science standards.
- Continue to build an effective and diverse team of science instructors, scaled to the program's demands.
- Update instructional equipment and graphics as needed.
- Continue to achieve a high level of maintenance and safety.
- Play an active role in the AWRI Director search and transition process.

Mid term

- Enhance curriculum connections between vessel/classroom programs and the current research of AWRI scientists.
- Make coverage of climate change more explicit in the vessel curriculum.
- Review program evaluation and demographic data and assess through a DEIAB lens.
- Consider developing pre- and post-cruise resources to enhance student learning.
- Conduct/coordinate professional development for K-12 educators in response to opportunities and needs.

Long term

- Expand partnerships that increase the program's reach of groups that are historically underserved by science education.
- Explore opportunities for integrating the arts into AWRI outreach and education programs.
- Explore opportunities for expanded funding of the outreach program.

Appendices

Vessel Program Data

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
2023	116	2,488	350	800	478	38	822	42
Total	**3,931**	**93,227**	**7,078**	**26,859**	**21,582**	**2,345**	**26,103**	**9,331**

[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

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
2023	85	1,623	258	422	332	363	248	0
Total	**4,591**	**99,114**	**12,086**	**25,325**	**19,559**	**16,318**	**17,480**	**8,346**

[4] Due to the COVID-19 pandemic, the vessel did not operate in 2020 and operated in the Fall 2021 season only
[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
2023	201	4,111	608	1222	810	401	1070	42
Total	**8,522**	**192,330**	**19,164**	**52,184**	**41,141**	**18,663**	**43,583**	**17,677**

[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

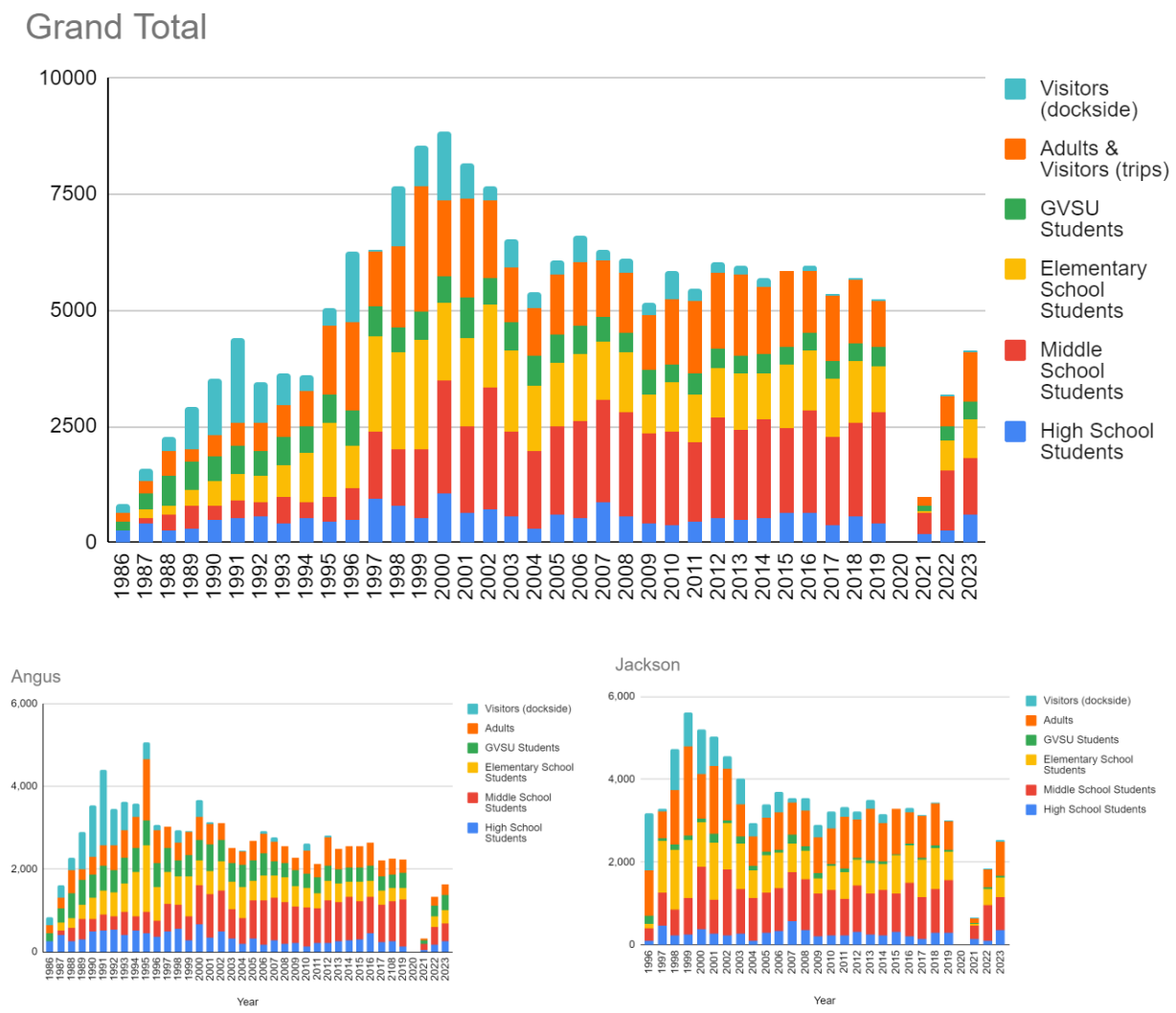


Figure 2. Percentage of Groups by Age Aboard AWRI vessels

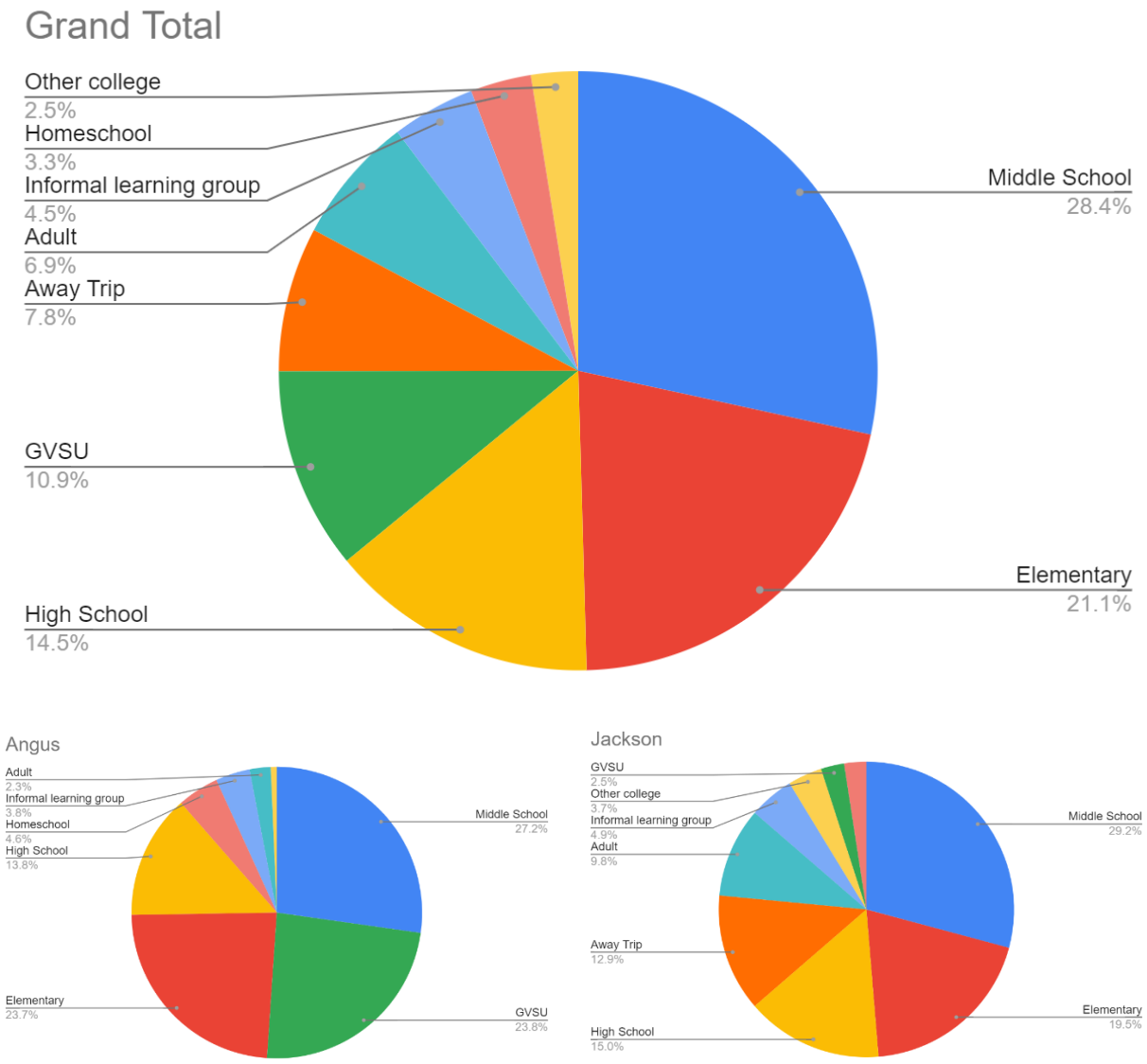


Table 4. Number of Groups listed by County Aboard AWRI Vessels

County	*D.J. Angus*	*W.G. Jackson*	Grand Total
Allegan	2		2
Calhoun	2		2
Clinton	1		1
Eaton		1	1
Ingham		4	4
Ionia		2	2
Jackson	1		1
Kalamazoo	3	2	5
Kent	25	29	54
Lake		2	2
Marion (Iowa)		1	1
Mason		2	2
Muskegon	10	38	48
Newaygo		3	3
Oceana		2	2
Ottawa	41	11	52
VanBuren		1	1
Various (Indiana)		15	15
Various (International)		2	2
Various (National)		1	1
Total	**85**	**116**	**201**

Figure 3. Percentage of Trips by County Aboard AWRI vessels

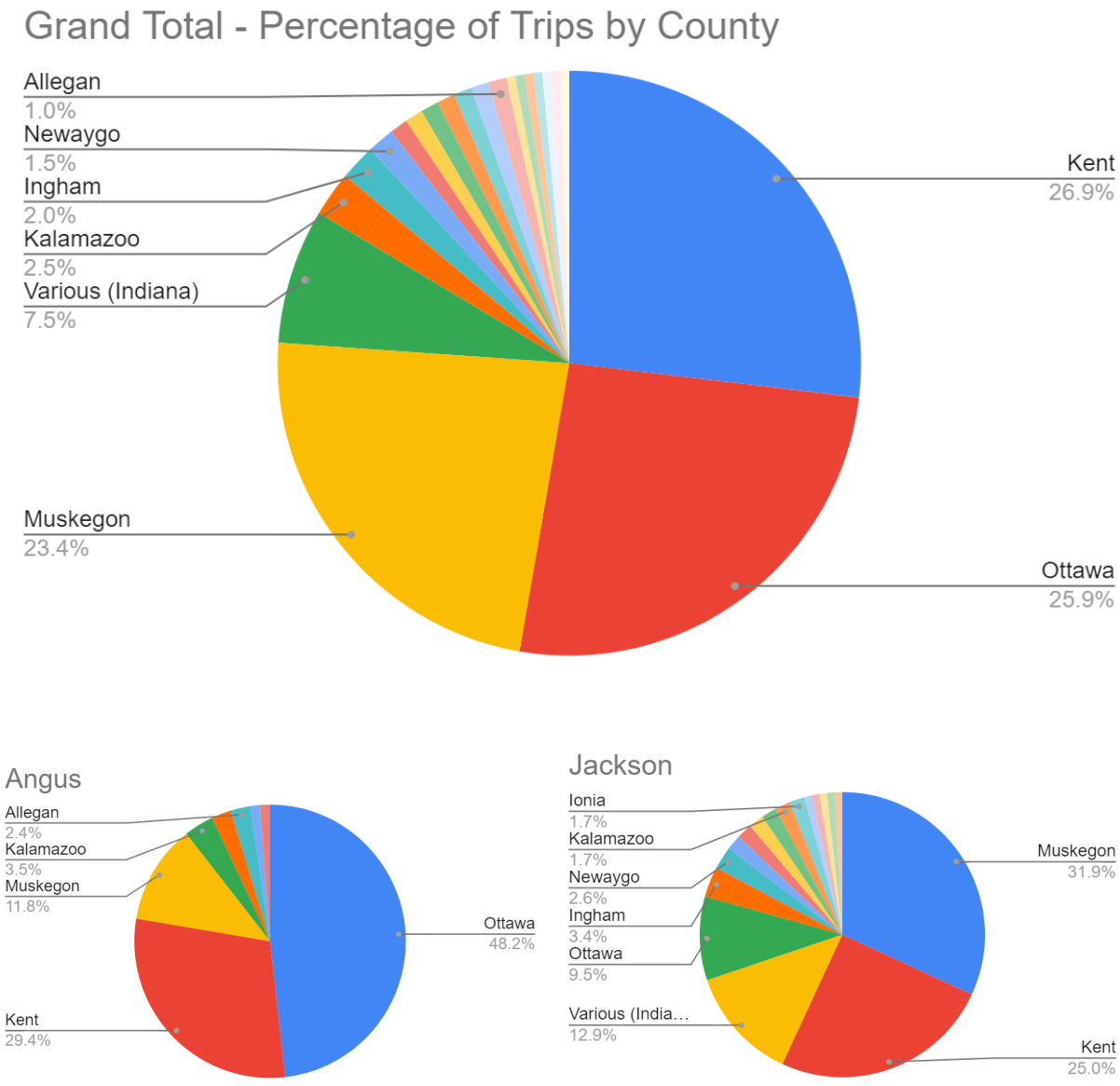
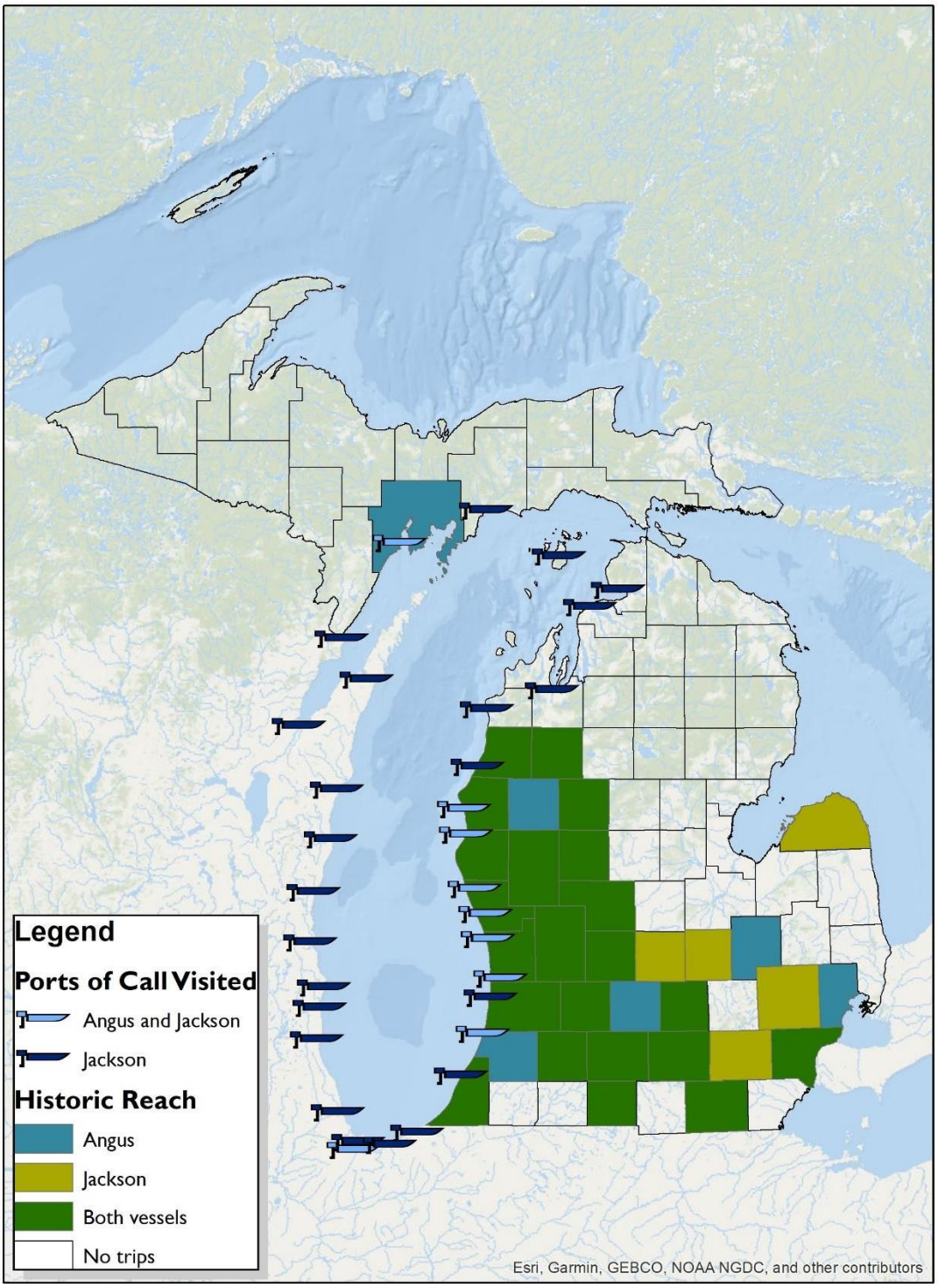


Figure 4. Map of the Historic Reach of the Vessel Program

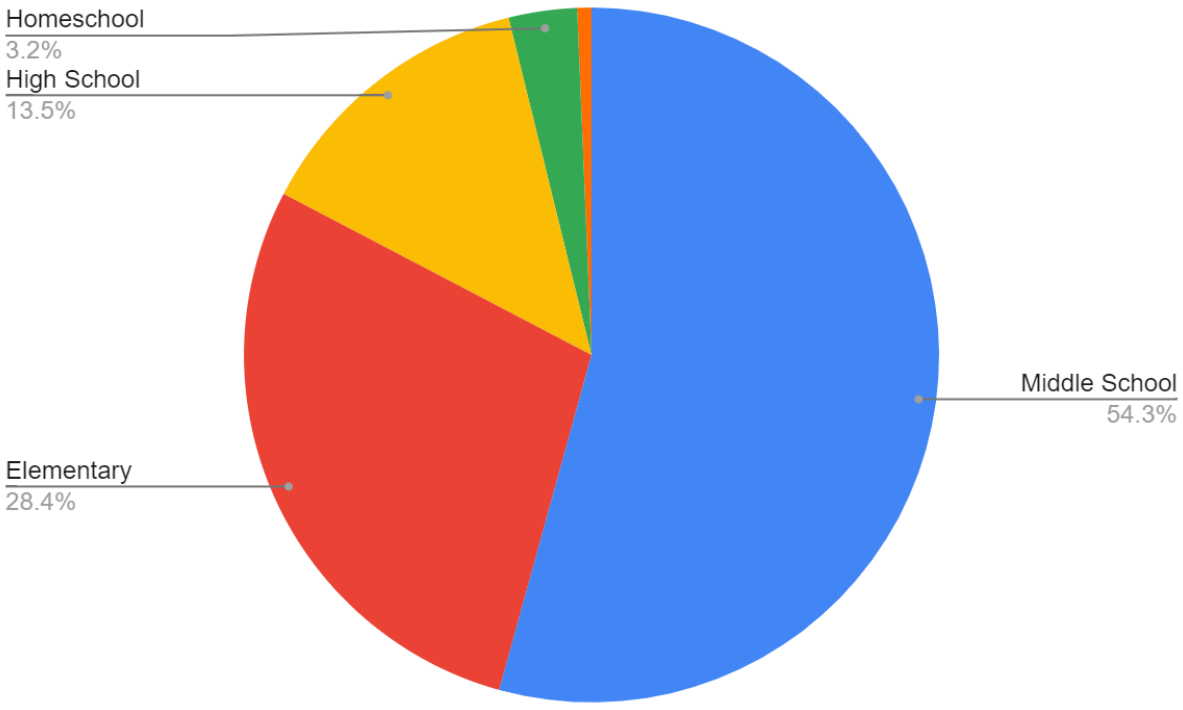


Geographic representation of overall usage of the *D.J. Angus* and *W.G. Jackson* from 1986 to 2023. Ports of call visited in Lake Michigan are represented by boat icons. Michigan counties are color coded if groups from that county have used the vessels.

Table 5. Number of groups and individuals by age group participating in the Landside Program

Age Group	Number of Groups	Number of Participants
Middle School	16	495
Elementary	7	259
High School	7	123
Homeschool	1	29
Informal learning group	1	6
Grand Total	**32**	**912**

Figure 5. Percentage of Landside Program participants by age group



Note: The Homeschool groups that participated in the landside program were mixed age groups, and therefore were counted in their own category.

Table 6. Number of groups by county using the Landside Program

County	Number of Groups
Muskegon	16
Kent	7
Ottawa	3
Newaygo	2
Kalamazoo	1
Iowa	1
Ingham	1
Eaton	1
Grand Total	**32**

Table 7. New vs. Returning Users of the Vessel Program

Is this your group's first time on our vessels?	Number of Groups	% of Groups
Yes (new user)	53	26%
No (returning user)	67	33%
Unsure	7	3%
No response	74	37%

Table 8. New vs. Returning Users of the Landside Program

Is this your group's first time at our program?	Number of Groups	% of Groups
Yes (new user)	14	44%
No (returning user)	16	50%
Unsure	2	6%

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Vessel Program Staff

Administrative
Christina Catanese, Education Specialist
Mark Luttenton, Interim Director
Tonya Brown, AWRI Assistant
Roxana Taylor, AWRI Secretary (through May 2023)
Cheryl Kastas, AWRI Secretary (August 2023 - current)

Science Instructors (vessels)
Paula Capizzi, Lead Instructor D.J. Angus
Jamie Cross, Lead Instructor W.G. Jackson
Doug Haywick, Science Instructor
Ann Hesselsweet, Science Instructor
Tom Jackson, Science Instructor
Bob Myers, Science Instructor
Diane Veneklasen, Science Instructor

Science Instructors (landside)
Amanda Syers, Science Education Specialist
Jill Keisling, Science Instructor
Lynn Knopf, Science Instructor
Meryl Luoma-Mannisto, Assistant Science Instructor
Audrey Whitaker, Assistant Science Instructor

Captains
Eric Hecox, Fleet Captain
Paul Haley, Captain, *W.G. Jackson*
Tom Hampton, Captain, *W.G. Jackson* and *D.J. Angus*
Jill Johnson, Captain, *D.J. Angus*
Ed Perrault, Captain, *W.G. Jackson* and *D.J. Angus*

Deckhands
Terry Boersen, Deckhand
Dave Fisher, Engineer, *W.G. Jackson*
Tim Halloran, Deckhand, *W.G. Jackson*
Pete Hewett, Engineer, *D.J. Angus*
Jeffrey Hughes, Deckhand
William Young, Deckhand

Groups using the *W.G. Jackson* in 2023

Eaton
Potterville High School

Ingham
Okemos High School
Stackridge Junior/Senior High
Wilson Talent Center - Biosciences

Ionia
Jefferson Elementary

Kalamazoo
Vicksburg High School
Western Michigan University - Hydro Field Camp

Kent
Ada Vista Elementary
Alto Elementary School
Center for Economicology
Dutton Elementary
East Grand Rapids Middle School
Grand Rapids Community College
GVSU PH 520 Environmental Health
GVSU Student Academic Success Center
Kamp Home School
Murray Lake Elementary School
Rockford Christian

Lake
Baldwin Community Schools

Marion (Iowa)
Knoxville High School Science Club

Mason
Ludington High School

Muskegon
AWRI Friends & Family Picnic
Baker College of Nursing
Boys & Girls Club of the Muskegon Lakeshore
Bunker Elementary
Consumers Energy Foundation
Development Cruise
Duck Creek Learning Center
EGLE Plankton/Algae Course
Fruitport Middle School

Muskegon, cont.
Holy Family Homeschool
Innovative Learning Center
Martin Luther King Elementary School
Mona Shores High School Ecology Class
Mona Shores Middle School STEM
Muskegon In Focus
Muskegon Lake Monitoring
Nelson Neighborhood Improvement Association
Ravenna High School
Ravenna Middle School
Reeths Puffer Intermediate School
Three Oaks Public School

Newaygo
Girl Scout Troup 4838
Hesperia High School

Oceana
Pentwater Public Schools
Walkerville Public Schools

Ottawa
Allendale High School
Spring Lake Intermediate School
Wisdom Homeschool Co-op

Van Buren
Hartford High School

GVSU
GVSU - Fisheries and Aquatic Sciences Club
GVSU CLAS Academic Advising Center

Various (Indiana)
Indiana Department of Environmental Management
Michigan City Sanitary District

Various (National)
National Educational Telecommunications Association conference

Various (International)
African Center for Aquatic Research and Education (ACARE)'s African Women in Science group
GVSU Economics / Poland Group

Groups using the *D.J. Angus* in 2023

Allegan
Allegan High School
Saugatuck High School

Calhoun
GVSU ExCEL Summer Camp - Battle Creek Central High School

Clinton
Bath High School Science NHS

Jackson
BSA Troop 4424

Kalamazoo
St. Augustine School
Zion Lutheran

Kent
Calvin College Oceanography
Cherry Creek Elementary
Grand Rapids Montessori
Grandville Public Schools
Grandville Public School
Holy Trinity
Homeschool
Kellogsville High School
Link Homeschool
Northview Public Schools
The Potter's House High School
West Michigan Academy of Env. Science
Zion Christian School

Muskegon
Calvary Christian Schools
Fruitport Middle School
Reeths-Puffer Middle School

Ottawa
Central High School
Classical Conversations
Grand Haven High School
Jenison ACT
League of Women Voters
Oakwood Intermediate
Ottawa 4-H

GVSU
GVSU Biology 107
GVSU/ Geology 105
GVSU/BIO 215
GVSU/Biology 107
GVSU/Biology 362
GVSU/EDI 631
GVSU/Geology 103/105
GVSU/Geology 105
GVSU/HNR Biology
GVSU/Limnology

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 questions in the following pages). All of the evaluation forms for 2023 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 qualitative feedback via comments on what aspect of the cruise resonated the most and how it could be applied in their classroom, as well as open-ended comments. These responses 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. All of the qualitative feedback received has been transcribed and is provided below.

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. Teachers also noted that for older groups, the cruise helped illuminate the possibility of careers in aquatic science for their students. 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 many students have not 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. 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. This year, several teachers expressed interest in learning more about climate change and climate action, especially among higher education groups.

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.

This year, the landside program developed a new evaluation tool to receive comparable feedback to the vessel program. All ten respondents said that the program was the right amount of challenge for their students and that it provided a hands-on science learning opportunity. All also agreed with the statement "This program strengthened my students' understanding of the connection between land and water." (6 Strongly agree, 4 somewhat agree). Perhaps most encouragingly, 7 out of 10 felt more comfortable with bringing their students outdoors to learn, compared to before they experienced the program at AWRI, with half of the teachers saying they felt much more comfortable. This feels like a real demonstration of the value and importance of our outdoor place-based engagement with students, in which we can model the potential for teachers to continue their students' learning outdoors back at school. Activities that stood out landside were contributing to citizen science efforts, macroinvertebrate identification, and activities that got the students physically moving.

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:

Landside Program:

1. This program strengthened my students' understanding of the connection between land and water.
Strongly agree Somewhat agree Neither agree nor disagree Somewhat disagree Strongly disagree

2. This program provided my students with hands-on science learning opportunities.
Strongly agree Somewhat agree Neither agree nor disagree Somewhat disagree Strongly disagree

3. Compared to before you experienced this program, how comfortable do you feel with bringing your students outdoors to learn?
Much more Somewhat more About the same Somewhat less Much less

4. For your students, was this program:
Much too advanced Somewhat too advanced The right amount of challenge Somewhat too easy Much too easy

5. On a scale of 1 (poor) to 7 (excellent), how would you rate this learning opportunity for your students?
7 6 5 4 3 2 1

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

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*
  - That Science is active and useful
  - every child has a job!
  - How human factors affect water quality
  - It made the connections between science and math very clear. We can learn from this as we study the stream back at school
  - The hands on activities were so fun and engaging
  - The outside work
  - We've been working on rounding/adding decimals. Loved that we did that. We also had a geology unit earlier in the year-great to see it come alive!
  - Water quality and how we change it. Connects to our class because we raise salmon in our classroom
  - The analysis of data was great-the act of analyzing data and practice is what I can take back to the classroom
  - The water quality of the lake. We will have a conversation about how humans can change the environment
  - The analysis of the data was great as well as the visual of the dunes vs. how they looked in the past
  - We loved doing the tests and seeing the dunes and different aspects of the lake
  - The hands on experience is awesome.
  - The effect people have on the quality of our Great Lakes. We will continue to learn about preserving our environment and how to take action to protect our world!
  - The knowledge base and enthusiasm captured their attention.
  - We can take back our data to discuss
  - The scientific process, investigating and averages
  - Learning: knowing about types of water nutrients in Lake Michigan and Muskegon Lake

- *Middle School*
  - Local STEM and hands-on science! Local matters the most
  - This could be a continuous learning experience even [incomprehensible]….the Michigan curriculum
  - The core areas of English, social studies, math and science were incorporated into the presentation. Watching some of my students come to life through this experience.
  - Allowing students to do the work and discovery. Continuing our conversations about protecting our watershed
  - Instructors went above and beyond to connect to Economicology. We will reflect on this experience throughout our studies.
  - Recording and using data. The history of Lake MI and other Great Lakes.
  - Allowing for the hands on science, connecting students to the content and promoting engagement.
  - Being able to compare the water quality of the lake to our local area and knowing how we affect it. Also seeing the testing procedures is very interesting
  - This was an excellent experience for students. The hands on scientific activities helped them see real world science in action. You then tied it all together with the wrap up activity
  - Basic knowledge of LM and Muskegon Lake.
  - Water samples and secchi disk. The connections with our school curriculum.
  - The students seemed engaged 95% of the time. We are surrounded by lakes near our school. We can continue discussion about water quality in those lakes as well.

- Students will be using sensors to compare this research with our research in our school ponds as well as water quality in Lake Huron and the Florida Keys.
- Invasive species, predator/prey, impact of humans on ecosystems, population changes from species to species relationships, mean/average, scientific process
- Student centered
- Students love hands on activity
- Science-water, invasive species, etc. SS, economics, tourism, etc.
- Microscope portion. Chemical H2O testing. Connection Human impacts to our water.
- pH info. Human pollution. Invasive species
- Learning about and comparing the 2 water systems and incorporating math
- The types of color of water and what that means for animals. Talking about pollution types and how it affects ecosystems
- Hands on lab experience
- Eutrophic - talk about during pollution unit
- Hands-on learning
- Turbidity testing with secchi disc and plankton/all stations were amazing. Picking organisms from sediments. Learning about G.L. watershed and water cycle.
- Hands on learning is always the best.
- Learning about invasive species and how the [sic] affect the food chain
- Water sampling resonated the most
- hands on, having chance to do things they never have, some kids have never been on a boat even. Water projects, environmental issues.
- Type of lake (O,M,E) and what lives in it.
- The last 1/4 re. fish introduction, invasion and the slides was [sic] a favorite. The first 1/4 inside was a little technical with short instruction.
- Getting a chance to draw water and test it was a great experience for the students.
- I loved the scientific and experimental approach to learn about the Muskegon River watershed.
- Data collection and lab work.
- Our classes are studying droughts in the S.W. They have learned water quality is a key aspect of droughts. The classes have learned that Michigan sits on the biggest fresh watershed in the world. They have learned that we need to protect our water source. This trip has given us a hands-on experience on our water unit study.
- We spend quite a bit of time talking about/studying ecosystems, invasive species and human interactions!
- Very hands on and engaging. Students will apply data/observations in their current ecosystems unit. Everything went very well!
- This is our second year and I am even more impressed. Including all students. Concluding data. History. Being aware of our awesome state.
- Science inquiry that matches our curriculum
- Lab work and hands on opportunities.
- O, M, E!
- This is their first experience with water quality and chemistry. We will be using the experience directly into their informational text unit on water.
- The aspect that resonated the most was through how it related to class.
- Yes! They loved being able to participate as scientists!
- Chemistry understanding factors affecting the lake + students doing real-world science-environmental science
- This group of students was more engaged than the morning group. I think the “invasives: discussion resonated the most with students
- Hands on activities. Can use the data in my math class
- You guys do an amazing job engaging our students. Thank you!

- The hands on experience in the lab and on the deck
- The trip always makes our previous classroom learning "real" and helps pave the way for future learning and labs.
- It introduces so many upcoming units for us. It also ties in previous content for them, so it blends all together so well for them
- Human/environment interactions and invasive species. Our students can better understand their role in the environment and how to take care of it.
- The trip does a great job talking about what we learned in 6th grade and what we will learn in 7th grade! Thank you!
- Amazing as always! We look forward to investigating more in class!
- Thank you! [smiley face]
- Students love the inquiry based approach that you all follow. Thank you!
- Trophic status/data collection skills
- Lab and physical testing. Invasive species
- It was amazing! The labs were great.
- They always return ready to more deeply explore concepts we started to learn about before the research vessel trip
- Students loved getting a job to do - hands-on science!
- The difference between the water quality in various [indecipherable word]. It helps them understand where it is more wise to fish, sail and do water activities

- *High School*
  - The importance of data collection for developing understanding
  - They will be taking this whole experience back with them
  - The chemical testing
  - Differences between eutrophic and oligotrophic water and the significance of invasive species
  - How the scientific process is used right here in the community
  - The students were real world scientists! Most have never even been on a boat before
  - Discussion of invasives, Hands-on experience. We will continue our discussions in class!
  - The trip aligns well with what students are learning in class
  - This will help our students understand the water cycle, scientific method, pollution, ecosystems all of which were covered in class.
  - Hands on with equipment. Water quality tests will be performed in the classroom using samples from local systems for comparison.
  - Loved that all the students had a chance to work hands on with testing and making observations. Would bring more activity based activities back to the classroom.
  - Hands on learning and data-driven conclusions. The realities and challenges of field research
  - Reinforcement of proper lab procedures was nice. It was great for them to see science in action-always hear “when am I ever going to use this?”. Now they have a real life example.
  - Connect the experience to local testing that is done. Seeing similarities between this and what we’ve done.
  - We are starting a unit on water quality. I think talking about factors like DO, temp, nitrate and phosphorus in particular are useful. Cool to see the microscopic organisms on the screen.
  - Hands on activities using more science for programming
  - Bring the abiotic and biotic factors and how we change them. Also relate that for inquiry as we do salmon in the classroom
  - Lab skills and data collection was outstanding and had multiple "levels" of difficulty.
  - How lakes are important and how to protect them.

- The ability to monitor the health of lake [sic] and the realization of our amazing resource [sic] and freshwater lakes are [sic]
- Data!! This perfectly connected classroom learning to real world experience! Thank you!
- Hands on realistic research. How all of core curriculum can be used in every day real world sciences.

- *Landside*
  - Different temperature based on sun. Property location
  - Connecting activities to prior lessons/classes Collecting/entering data in citizen science databases
  - The lab work on the boat. We can replicate some of it in a class
  - I liked the hands on activities
  - We love the hands on experience
  - Good exposure for 6th graders /data collection. We can expand upon it.
  - The macro invertebrates-try testing by us.
  - We love the hands on experience
  - We love the activities that have the kids moving around. Students are working on the water cycle in school as well.
  - Building connections to what they are learning in class.

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

- Excellent lessons covered on public health and climate change
- You covered many good topics including very recent developments such as PFAS on lakeshore sites. I can't think of any other topics!
- Covered a lot, good breath, appreciated you catering some of the work/discussion to geosciences - excellent! +upper level science
- fish sampling, fish parasitology, fish health, microplastic monitoring, weather (enviroconditions)
- None- this was perfect! Covered all of our classroom content!
- Great overview
- More info on climate preservation, how to "do our part"
- Testing changes with season, for a group of educators - consider talking the why of how you are teaching
- All great! 5 stars!
- Everything was really good. Kids really enjoyed the cruise
- Missed Lake Michigan due to weather; Nitrate cycle
- I don't do much with plankton, but a poster with examples of 3 dif water bodies would be great
- None that I can think of now.
- Not that I can think of. Good mix of bio/geo/human interest
- was wonderful
- snacks [smiley face]
- IT WAS GREAT!!
- None. Wonderful cruise and covered so much!
- Not much time for more!
- It was great !
- Nope. It was great
- Honestly, the variety of content has been great and the history connections were cool to hear about
- Nothing I can think of right now
- It was great - lots of hands on experience sampling