2025 MATE ROV COMPETITION: PRODUCT DEMONSTRATION AND SPECS BRIEFING

MATE Competition Philosophy

The MATE ROV competition is about **student learning**.

It is designed to be an event that challenges **students** to apply the physics, math, electronics, and engineering skills they are learning in the classroom to solving problems from the workplace.

Mentors (teachers, parents, working professionals) are expected to limit their input to educational and inspirational roles and encouraged to focus on the benefits of the **learning process** and not simply on "winning" the competition.

UN Decade of the Ocean, MATE Year of the Great Lakes: Monitoring and Mitigating the Impacts of Climate Change on Our Water World

CONTEXT & NEED

As we dive into another MATE ROV Competition season (and our second year as part of the Marine Technology Society!) we continue to highlight scenarios aligned with the United Nations Decade of Ocean Science for Sustainable Development (2021-2030) while adding a new twist – tackling mission tasks in the Great Lakes!

Rising temperatures, extreme weather, damaged ecosystems, and rising sea levels are affecting all parts of our world, and the Great Lakes are no exception. Home to 84% of North America's surface fresh water and 21% of the world's fresh water, the Great Lakes are one of the world's largest surface freshwater ecosystems. They are becoming ever more threatened as our planet's temperatures continue to rise. We know that our ocean is becoming more acidic as it absorbs carbon dioxide that human activity releases into the atmosphere; studies based on computer models suggest that this same phenomenon may also be happening in big, freshwater systems, such as the Great Lakes. Besides disrupting aquatic life and habitat, acidification could deteriorate the thousands of wooden shipwrecks believed to be resting on the bottom, the majority of which have yet to be discovered.

What impact does a warming, freshwater ecosystem have on these cultural resources? That is an important question for Thunder Bay National Marine Sanctuary (TBNMS). One of 16 national marine sanctuaries managed by the U.S. National Oceanic and Atmospheric Administration (NOAA), TBNMS is charged with protecting a significant collection of nearly 100 historic shipwrecks in Lake Huron off the U.S. state of Michigan coast.

The 2025 competition mission tasks challenge you to help answer that question by documenting a shipwreck, installing sensors on a moored buoy for long-term monitoring, and collecting a water sample to measure pH and to detect eDNA to identify the presence (or absence) of an invasive species, which is only compounding the disruptive impacts of climate change on Great Lakes ecosystems. Moving from fresh to saltwater, this year's tasks also require you to maintain offshore wind farms and monitor the impacts of these structures and floating solar panel arrays on organisms that range in size from jellyfish medusa to blue whales. Finally, in 2025, we continue to task you to deploy a vertical profiling float, one

that can collect and contribute data to a global repository, enabling us to collectively and collaboratively monitor ocean health.

We launch the 2025 season with continued optimism that together we can inspire, innovate, and create technology solutions to mitigate the impacts of climate change and pave the way to a sustainable future for both our ocean and the Great Lakes. And with the technologies that enable increased and improved monitoring and data collection to support us, we remain optimistic that we can influence mindsets and guide communities to embrace and adapt practices for the good of us all.

If you have competed in the MATE ROV Competition in the last 4 years, it will come as no surprise that once again this (our 23rd!) competition season the "client" is us: our global community of learners, inspired by the ocean, innovating and collaborating to address environmental and societal challenges. Our 2025 scenarios and mission tasks continue to inspire ESG and acknowledge and embrace the UN's Sustainable Development Goals and its 10 Challenges for Collective Impact," while also calling attention to the similar climate challenges that are facing freshwater ecosystems.

Again this year we are tasking our MATE competition community to design and build a remotely operated vehicle and the necessary sensors, tooling, and complementary technologies to combat climate change, provide clean energy, protect ecosystems from invasive invaders, and monitor the health of the salt- and freshwater habitats of our Blue Planet. Equipped with scientific data and technology solutions and with an understanding of the actions that we need to take, we can proactively and confidently move from the aquatic ecosystems we have to the ocean, rivers, lakes, and streams we want.

Albeit we won't be able to make that move without an appropriately educated and skilled workforce, one that is aware of and informed about the challenges we face and prepared to apply knowledge and skills to tackling them.

And this is where you come in – and where your mission begins.

Overarching:
Ocean Decade Challenges for collective impact:

- **#9: Skills, knowledge, and technology for all**

Task #1: Shipwrecks, Spotter Buoys, and Flying Fish: Documenting the Impact of Climate Change and Invasive Species on the Great Lakes
Ocean Decade Challenges for collective impact:

- **#2: Protect and restore ecosystems and biodiversity**
- **#7: Expand the Global Ocean Observing System**
- **#8: Create a digital representation of the ocean**

Task #2: Marine Renewable Energy: Producing Power from Our Planet While Monitoring Environmental Impact
Ocean Decade Challenges for collective impact:

#2: Protect and restore ecosystems and biodiversity
#4: Develop a sustainable and equitable ocean economy

Task #3: MATE Floats!
Ocean Decade Challenges for collective impact:

#5: Unlock ocean-based solutions to climate change
#7: Expand the Global Ocean Observing System
#8: Create a digital representation of the ocean

REFERENCES

- United Nations Decade of Ocean Science for Sustainable Development
- 17 UN Sustainable Development Goals
- 10 Challenges - Ocean Decade
- A Hotter Future Is Certain, Climate Panel Warns. But How Hot Is Up to Us.
- ESG (environmental, social and governance)
- Here's What Climate Change Is Doing to the Great Lakes
- Great Lakes Facts and Figures
- Scientists: Atmospheric carbon might turn lakes more acidic

Task #1: Shipwrecks, Spotter Buoys, and Flying Fish: Documenting the Impact of Climate Change and Invasive Species on the Great Lakes

- Frozen in Time: National Marine Sanctuary Researchers Discover Lost Shipwreck Ironton
- Thunder Bay National Marine Sanctuary (noaa.gov)
- Shipwrecks | Thunder Bay National Marine Sanctuary
- What are 360° photospheres? And what are panoramas?
- Spotter Platform - Subsurface
- Great-Lakes Region Acidification Research
- Freshwater Acidification Research in Thunder Bay Great Lakes Fishery Commission - Invasive Carps
- New Study Finds Asian Carp Threat to Lake Michigan Is Greater Than Previously Thought
- Deep Trouble: In hunt for Asian carp, scientists find DNA, controversy
- How eDNA technology is changing the game for protecting ocean species
- Location of the Illinois River basin

Task 2: Marine Renewable Energy: Producing Power from Our Planet While Monitoring Environmental Impact

- Top 10 Things You Didn't Know About Offshore Wind Energy
- What are the advantages and disadvantages of offshore wind farms?
- A metaheuristic optimization model for the inter-array layout planning of floating offshore wind farms
- Wind turbine design – Corrosion control challenges
- Singapore unveils one of the world's biggest floating solar panel farms

- Where the Sun Meets the Sea: Offshore Floating-PV Powers Singapore's Journey Toward Carbon Neutrality
- RWE And SolarDuck To Explore And Develop Offshore Floating Solar Parks Globally
- Jellyfish and Comb Jellies
- Potential environmental impacts of floating solar photovoltaic systems – Section 3.5.1 Fish
- Investigating the impacts of floating solar on the water environment
- Recent Advances in Autonomous Environmental Monitoring Technologies to Support Offshore Wind Energy

Task 3: MATE Floats!

- GO-BGC | Global Ocean Biogeochemistry Array
- Expanding Fleet of Autonomous Floating Robots Targets Deeper Understanding of Global Ocean Dynamics
- 2021 MATE Floats! | MATE ROV Competition Website
- Adopt-a-Float Newsletters | GO-BGC

DESIGN BRIEF

Below is a summary of the product demonstrations organized by competition class – EXPLORER, PIONEER, RANGER, NAVIGATOR, and SCOUT. All product demonstration tasks will be attempted in one product demonstration run.

Task #1: Shipwrecks, Spotter Buoys, and Flying Fish: Documenting the Impact of Climate Change and Invasive Species on the Great Lakes

EXPLORER, PIONEER, and RANGER class tasks:

Shipwrecks

- Use visual clues to determine the identity of an unknown shipwreck
  - Determine type of ship
  - Determine length of ship within 5 cm
  - Determine the cargo that the ship carried
- Create a 360° photosphere image of the shipwreck environment

Spotter buoys

- Replace a damaged thermistor on the subsurface Spotter buoy
  - Remove the damaged thermistor
  - Install a new thermistor
- Install a pC02 sensor to the subsurface Spotter buoy
  - Place pC02 sensor in designated area
  - Connect pC02 sensor to subsurface Spotter buoy

Collect a water sample

- **Acidification**
  - Measure the pH of the water sample
  - Measure the dissolved C02 levels of the water sample
- **eDNA of invasive carp**

    - Determine if the unknown sequences include invasive carp
    - Model invasive carp moving into the Illinois River watershed over time

NAVIGATOR and SCOUT tasks:

Shipwrecks - NAVIGATOR

- Use visual clues to determine the identity of an unknown shipwreck
    - Determine type of ship
    - Determine length of ship within 5 cm
    - Determine the cargo that the ship carried

Shipwrecks - SCOUT

- Recover items to determine the identity of an unknown shipwreck
    - Determine build date of ship
    - Determine home port of ship
    - Determine the cargo that the ship carried

Spotter buoys

- Replace a damaged thermistor sensor on the subsurface Spotter buoy
    - Remove the damaged thermistor
    - Install a new thermistor
- Install a pC02 sensor to the subsurface Spotter buoy
    - Place pC02 sensor in designated area
    - Connect pC02 sensor to subsurface Spotter buoy

Collect a water sample

- **Acidification**
    - Measure the pH of the water sample
    - Measure the dissolved C02 levels of the water sample
- **eDNA of invasive carp**
    - Determine if the unknown sequences include invasive carp

Task #2: Marine Renewable Energy: Producing Power from Our Planet While Monitoring Environmental Impact

EXPLORER, PIONEER, RANGER, and NAVIGATOR class tasks:

- Connect a floating solar panel array to the grid
    - Pick up the power connector
    - Install the power connector into the hub
- Cathodic protection of the offshore wind farm structure
    - Replace a sacrificial anode onto the base of an offshore wind farm
    - Conduct a visual inspection of the base structure
    - Apply an underwater epoxy patch to the corroded area
- Collect life stages of jellyfish
    - Collect polyp stage jellies attached to the solar panel array
    - Collect a medusa stage jelly from mid-water
- Collect fish species aggregated underneath the solar panel array
- Place a hydrophone in the designated location

SCOUT tasks:

- Connect a floating solar panel array to the grid
  - Pick up the power connector
  - Install the power connector into the hub
- Cathodic protection of the offshore wind farm structure
  - Replace a sacrificial anode onto the base of an offshore wind farm
  - Apply underwater epoxy paint patch to a corroded area
- Collect life stages of jellyfish
  - Collect polyp stage jellies attached to the solar panel array
  - Collect a medusa stage jelly from mid-water
- Collect fish species aggregated underneath the solar panel array
- Place a hydrophone in the designated location

Task #3: MATE Floats!

MATE Floats! 2025 is inspired by the National Science Foundation (NSF)-funded GO-BGC Project. The goal of GO-BGC is to build a global network of profiling floats with chemical and biological sensors to monitor circulation, chemistry, biology, and overall ocean health. Scientists, engineers, and technicians are using NSF grant funds to build and deploy 500 robotic ocean-monitoring floats around the globe. As of August 2024, 217 out of the targeted 500 GO-BGC floats have been deployed or will be deployed shortly. (For details, see the **Preview Mission** for your respective competition class.)

EXPLORER, PIONEER, and RANGER class tasks:

Design and construct an operational profiling float

- Prior to the competition, design and construct an operational vertical profiling float
- Float communicates with the mission station prior to descending
- Float completes two vertical profiles -
  - Vertical profile 1
    - Float completes first vertical profile
    - Float communicates data to mission station
    - Data verifies that the float maintains a depth of 2.5 meters
  - Vertical profile 2
    - Float completes second vertical profile
    - Float communicates data to mission station
    - Data verifies that the float maintains a depth of 2.5 meters
  - Profile graphed as depth over time

NAVIGATOR and SCOUT tasks:

- Design and construct an operational profiling float
- Float completes a vertical profile
  - Autonomously
  - Manually
- Float collects temperature data at four depths
- Graph temperature versus depth

SPECS

What follows is a summary of the electrical and fluid power requirements for each competition class. The complete design and building specifications will be included within the competition manual.

NOTE: Watch for new safety requirements and additional, detailed electrical specifications within the competition manuals.

EXPLORER

- 48 volts, 30 amps DC. Conversion to lower voltages must be done on the ROV, not topside.
- SBS50 Anderson Powerpoles, Littelfuse (30-amp or less) and Littlefuse fuse holders required on all vehicles. These specific components are REQUIRED.
- Pneumatics and hydraulics are permitted provided that the company follows the specifications included within the competition manual.
- Lasers are permitted provided that the team follows the specifications included within the competition manual.
- Camera is required.
- Depth requirement at the world championship: up to 5.5 meters.
- Maximum size: None. However, tasks will require companies to launch through a 1-meter x 1-meter square hole on the surface.
- Maximum weight: 35 kg. Vehicles above 35 kg will not be allowed to compete in the product demonstration. See below for additional details on weight requirements.

PIONEER

- 48 volts, 30 amps DC or 12 volts, 25 amps DC. If 48 volts is used, conversion to lower voltages must be done on the ROV, not topside.
- 48 volt systems must use SBS50 Anderson Powerpoles and Littelfuse (30-amp or less) and Littlefuse fuse holders on all vehicles. 12 volt systems must use ATO type blade fuses or MINI blade fuses for any fusing. These specific components are REQUIRED for vehicles using 48 volts or 12 volts.
- Pneumatics and hydraulics are permitted provided that the company follows the specifications included within the competition manual.
- Lasers are permitted provided that the team follows the specifications included within the competition manual.
- Camera is required.
- Depth requirement at the world championship: up to 5.5 meters.
- Maximum size: None. However, tasks will require companies to launch through a 1-meter x 1-meter square hole on the surface.
- Maximum weight: 35 kg. Vehicles above 35 kg will not be allowed to compete in the product demonstration. See below for additional details on weight requirements.

RANGER

- 12 volts, 25 amps DC. Conversion to lower voltages is permitted topside and on the ROV.
- 12 volt systems must use ATO type blade fuses or MINI blade fuses for any fusing. These fuses are REQUIRED for all vehicles.
- Pneumatics and hydraulics are permitted provided that the company follows the specifications included within the competition manual.
- Lasers are permitted provided that the team follows the specifications included within the competition manual.
- Camera is required.
- Depth requirement at the international competition: up to 5.5 meters. Depth requirement may vary at regional competitions. Contact your regional coordinator or check your regional competition information document.
- Maximum size: None. However, tasks will require companies to launch through a 1-meter x 1-meter square hole on the surface.
- Maximum weight: 25 kg. Vehicles above 25 kg will not be allowed to compete in the product demonstration. See below for additional details on weight requirements.

NAVIGATOR

- 12 volts, 15 amps DC. Conversion to lower voltages is permitted topside and on the ROV. Any onboard electrical power source is not permitted.
- Anderson Powerpole connectors are required on all vehicles. ATO type blade fuses or MINI blade fuses are required.
- Pneumatics and hydraulics are permitted provided that the company follows the specifications included within the competition manual.
- Lasers are permitted provided that the team follows the specifications included within the competition manual.
- Camera is required.
- Depth requirement: Varies depending on the regional event. Contact your regional coordinator or check your regional competition information document.
- Maximum size limit: None.

SCOUT

- 12 volts, 15 amps DC. Conversion to lower voltages is permitted topside and on the ROV. Any onboard electrical power source is not permitted.
- Anderson Powerpole connectors are required on all vehicles. ATO type blade fuses or MINI blade fuses are required.
- Manually powered hydraulics and pneumatics are permitted. Pneumatic systems cannot exceed ambient pool pressure and must follow the fluid power specifications included

within the competition manual.

- Lasers are NOT permitted.
- Depth requirement: Varies depending on the regional event. Contact your regional coordinator or check your regional competition information document.
- Maximum size limit: None.

WEIGHT POINT VALUES

Considering some of the environments in which the ROVs will be operating, an ROV weight requirement has been included in the request for proposals (RFP). Lighter vehicles will be given special consideration and vehicles above a certain weight will not be considered. Certain product demonstration tasks will also limit the overall size of the vehicle.

All weight measurements will include the vehicle and all tools and components but will not include the tether. The following will NOT be included in the weight measurement:

- The topside control system and the tether
- EXPLORER, PIONEER, and RANGER vertical profiling floats

EXPLORER & PIONEER

Weight (in air)	
< 18 kg	+10 points
18.01 kg to 25 kg	+5 points
25.01 kg to 35 kg	+0 points

Vehicles that cannot fit through the hole on the surface, or vehicles greater than 35 kg in weight will not be allowed to compete in the product demonstration.

RANGER

Weight (in air)	
< 15 kg	+10 points
15.01 kg to 20 kg	+5 points
20.01 kg to 25 kg	+0 points

Vehicles that cannot fit through the hole on the surface, or vehicles greater than 25 kg in weight will not be allowed to compete in the product demonstration.

NAVIGATOR and SCOUT

NAVIGATOR and SCOUT class companies do not have a weight limit. NAVIGATOR and SCOUT companies will not receive additional points for lighter weight vehicles.

NOTE for all classes: In addition to the weight limitations described above, companies must be able to transport the vehicle and associated equipment to the product demonstration station and to the engineering presentation room. The ROV systems must be capable of being safely hand launched.

RESOURCES

Companies are permitted to use the materials of their choice provided that they are safe, will not damage or otherwise mar the competition environment, and are within the defined design and building specifications.

Companies are encouraged to focus on engineering a vehicle to complete the product demonstration tasks, when considering design choices, teams should ask themselves which one most efficiently and effectively allows them to solve the problem. Re-using components built by previous team members is permitted provided that the current team members evaluate, understand, and can explain their engineering and operational principles. Using or re-using commercial components is also permitted, provided that team members evaluate, understand, and can explain their engineering and operational principles. Teams will be questioned extensively on their overall design and component selections during their engineering presentations.

TIME

The complete competition manual will be released in November 2024; teams have from that date until the regional events in the spring of 2025 to construct their vehicles and prepare the engineering and communication components (technical documentation, engineering presentations, and marketing displays). Visit www.materovcompetition.org for more information or join the MATE competition listserv to ensure a timely delivery of important information.