VideoRay

9 Tips for Operating Underwater Robots in Strong Currents

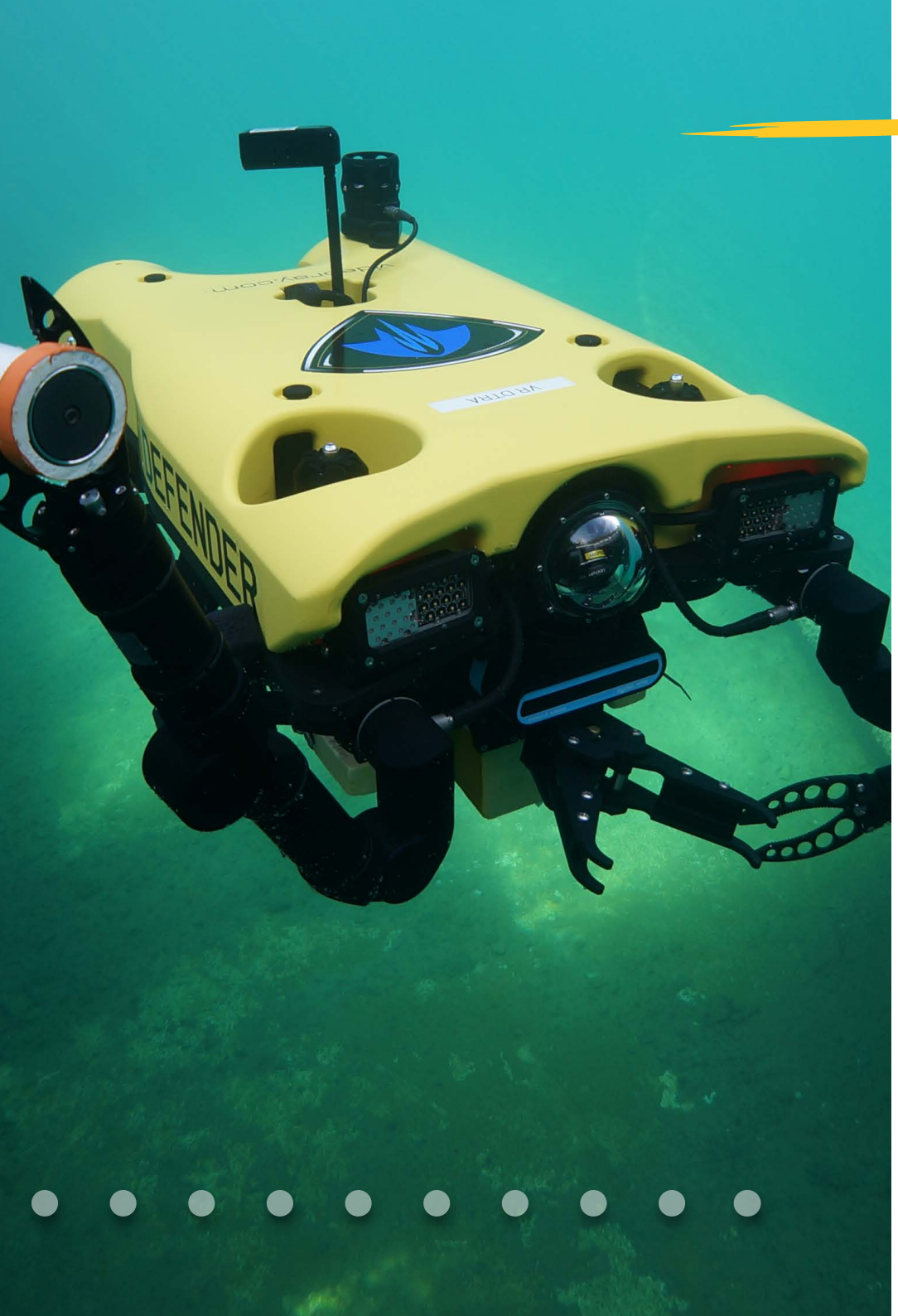
Working in strong currents present challenges that you may or may not be able to overcome with proper piloting techniques. For some missions, the situation may allow you to wait for optimal conditions, but others are more urgent and require immediate action. If you must pilot your underwater robotic system in strong currents, there are several strategies that you can apply depending on the situation. For this eBook, we identify strong currents as anything over 2 knots.

Keep in mind that currents can be inconsistent throughout depth, or there may be wind-driven currents on the surface and tidal or other currents below. This will of course, complicate the situation.

1. Keep Your Tether Short and Controlled

The tether not only keeps your submersible connected to the pilot, vessel, etc., it also powers your robotic system. Deploy as little tether in the water as possible in strong currents because it will act like a sail and pull on the robot. To avoid this, let the tether out slowly so the robot can travel down current or up current to the target. Keep in mind that drag increases when working perpendicular to the current.

If you're operating your robot from a ship, you will also need to be aware of the proximity of the tether to the ship's propellers, rudders or other obstacles. In rough seas, tethers with too much slack can easily become tangled, resulting in costly damage.



2. Understand Your Environment Before Deployment

Knowing what kind of environment you'll be working in before deploying your system is an essential step toward achieving a safe and successful mission. Important considerations include:

- Water depth
- Currents
- Obstacles
- Visibility

For new locations, this is particularly critical that you have some awareness of operating conditions during your mission.

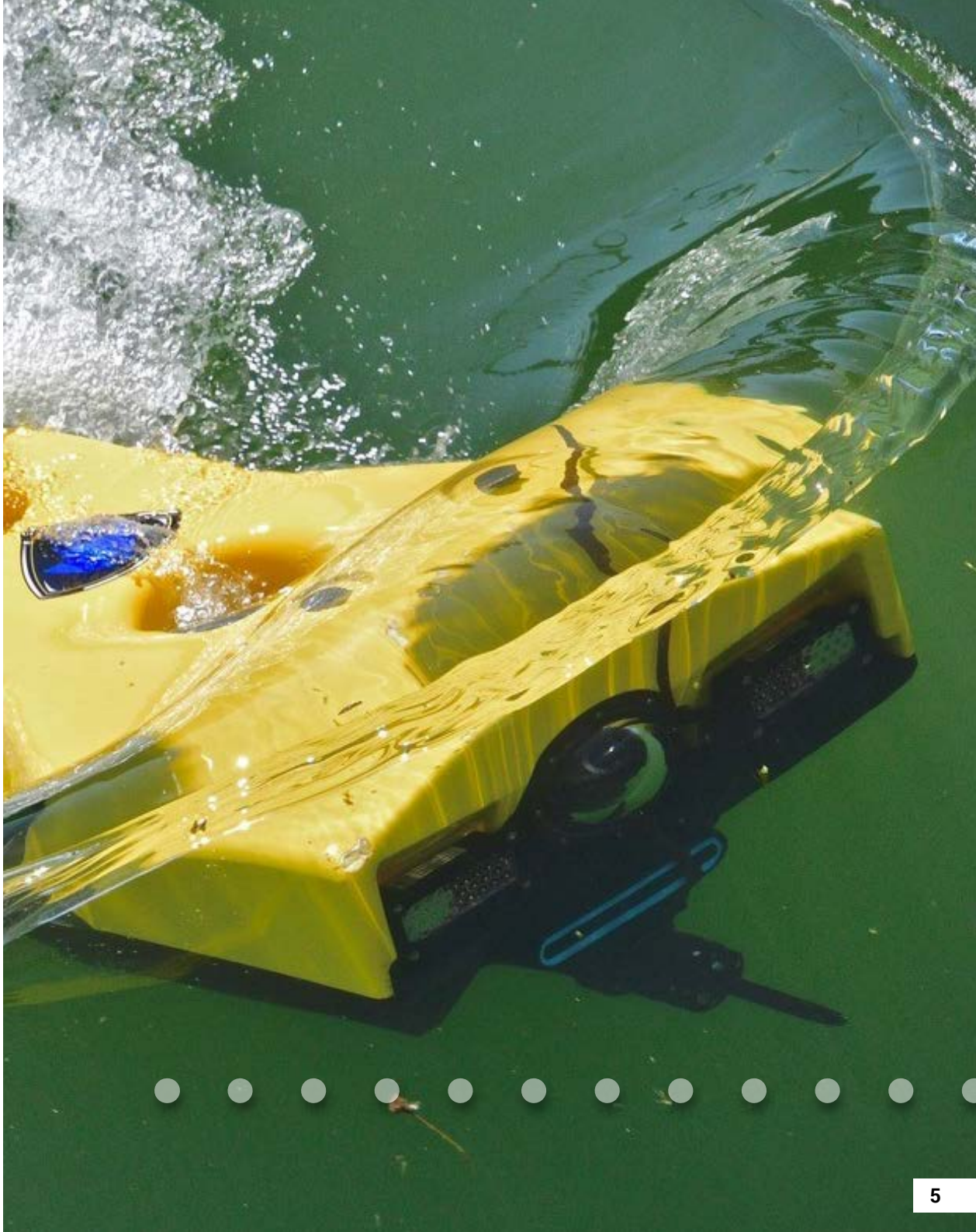
However, even known environments can have new obstacles or unforeseen changes prior to launch.

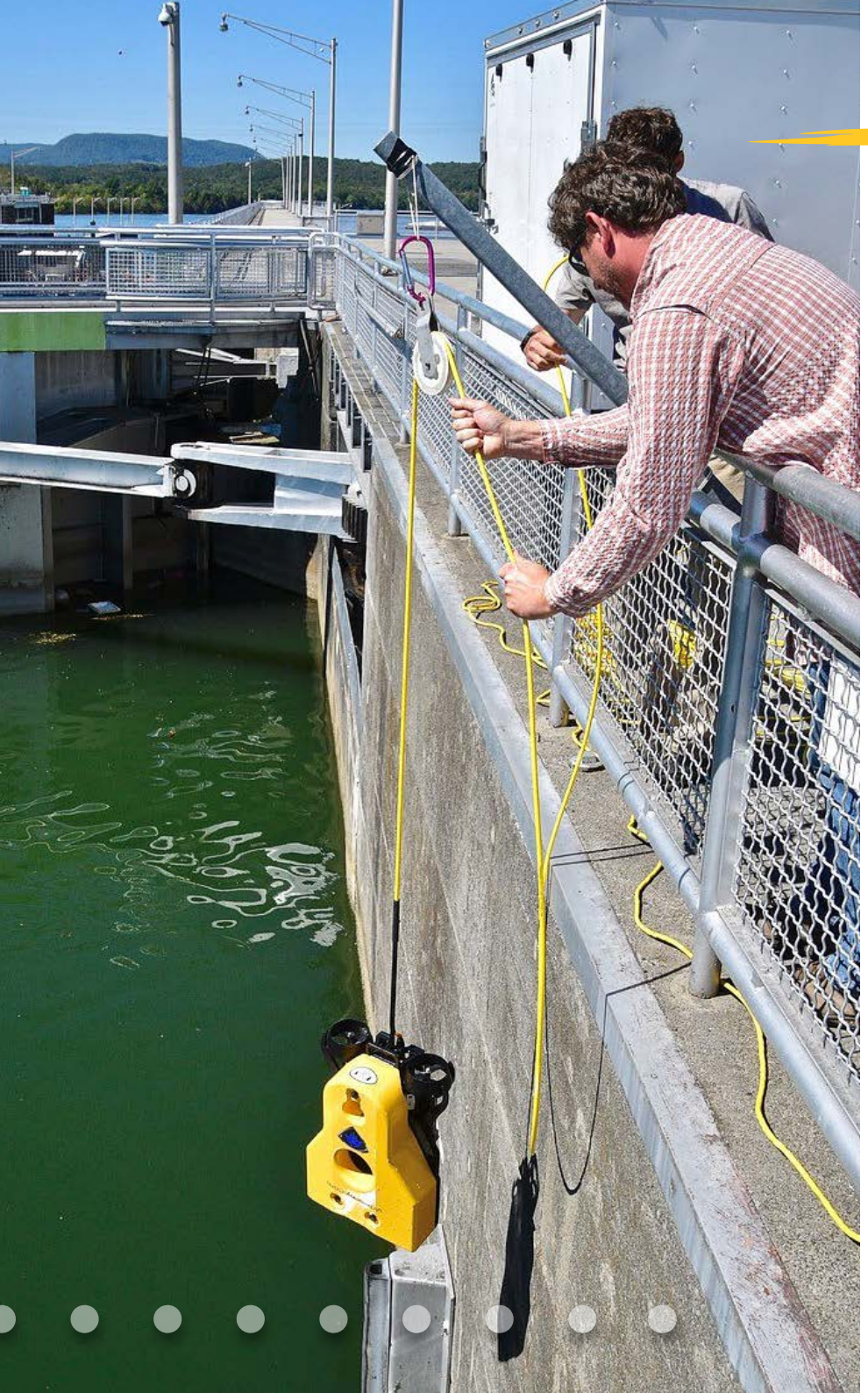
Use the Current to Your Advantage

As you maneuver your submersible, fly with the current using the tether like a fishing line to control the force on the robot. If you fly from shore, it is better to reposition your control box several times, rather than use too much tether in the water.

Natural current breaks, known as eddies, can help protect your robot from the current. Protection can be provided by a ship's hull, a structure in the water like a bridge footer, a protected area on a river, or even a ship wreck or other debris on the seafloor.

Heading into the current when possible can give you the best control over the robot. You will need to take a diagonal heading and "crab" across the current to reach your target rather than flying a straight line. Always remember, it is best to start upstream and go downstream with a short "leash."





Offset Tether Drag

Too much tether drag can make piloting in strong currents even more difficult and unpredictable. To help, use a clump weight on the tether,
when possible, to offset tether drag. This is especially helpful with surface and mid-water currents as the weight stabilizes the tether from the surface to the working depth.

Lash a carabiner or small weight bag to your tether behind the robot (safely spreading the load over at least six inches of tether) and leave a short leash for the required excursion. Add necessary weight(s) to the carabiner or bag until the tether hangs straight down in the water column.

Utilize Sonar

Sonar can also be a helpful tool, especially in conditions with low visibility. With sonar, you can prepare for the inspection/search by previewing the area first with a long-range sonar scan. This way you can identify underwater hazards like tree branches or other debris so you can plan your inspection strategically.

Some crews like to utilize simultaneous localization and mapping (SLAM) methods to build a map of their target area using sonar. With SLAM software, the system is able to pilot through an unfamiliar area while simultaneously mapping its own location in the environment. This is particularly helpful in confined areas or areas with large amounts of debris.

3. Make Sure the System is Optimized to Work in the Environment

Not all underwater robotic systems are created equal. Before you conduct your mission in an environment with a strong current, ensure that it was built to withstand these harsh conditions. Some key features to look for in a robotic system built for strong currents include:

Thrust

If your system doesn't have powerful thrust, you are probably not going to be able to operate in strong currents. Understand the thrust you have available during operations and how to command it when you need it. A general rule of thumb is to have around twice the amount of thrust to the robot's mass you are deploying.

Additionally, lateral thrust combined with an auto heading feature can make the vehicle more responsive and able to maintain heading better than a vehicle without lateral thrust.

Auto Heading

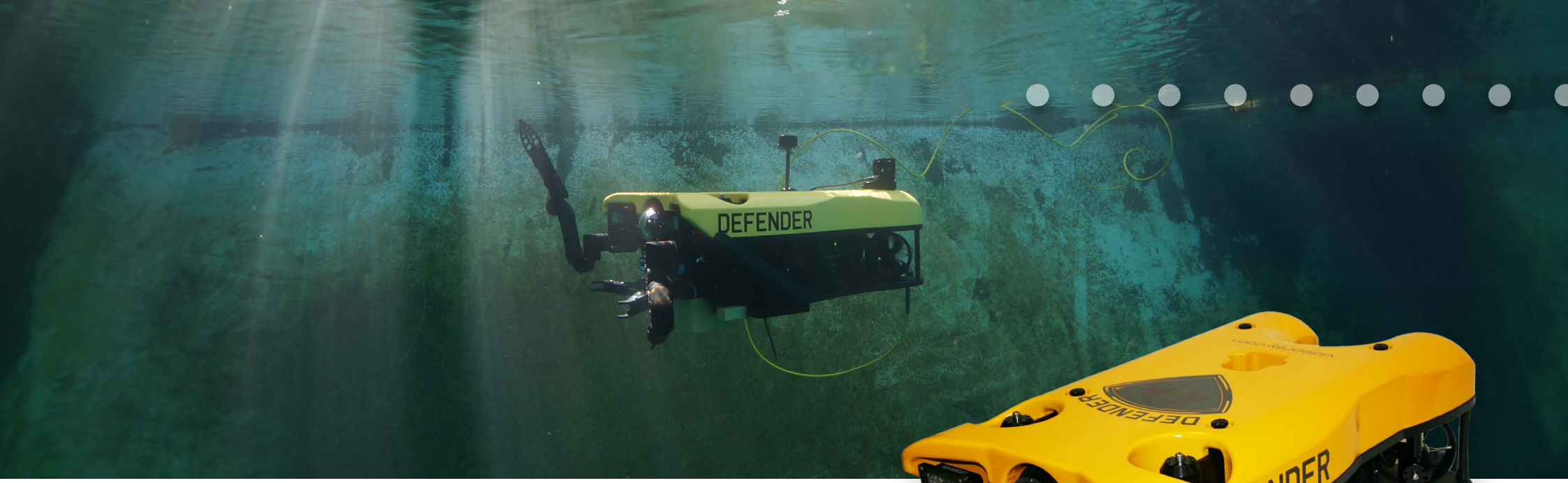
Auto heading can be used to maintain an existing heading or turn the robot to a specific heading. The feature is designed to be as seamless as possible so that you can pilot without having to constantly engage and disengage it when alternating between holding a course and changing directions. When auto heading is engaged, the robot will automatically respond to changes in heading (measured by the compass) by applying horizontal thrust to maintain the current heading.

Enhanced Power

Some systems, like VideoRay's Mission Specialist Defender, can also use onboard batteries and a copper or fiber tether, which is much thinner than a typical tether. This provides maximum power to the vehicle as there is no loss of power going down the tether. Additionally, a thinner tether reduces drag significantly, especially if the system must traverse a long distance.

VideoRay's Mission Specialist Defender system is known for producing incredible results for pilots offering superior performance and maneuverability.

Seven powerful thrusters provide you with six degrees of freedom control including lateral movement, pitch and roll.

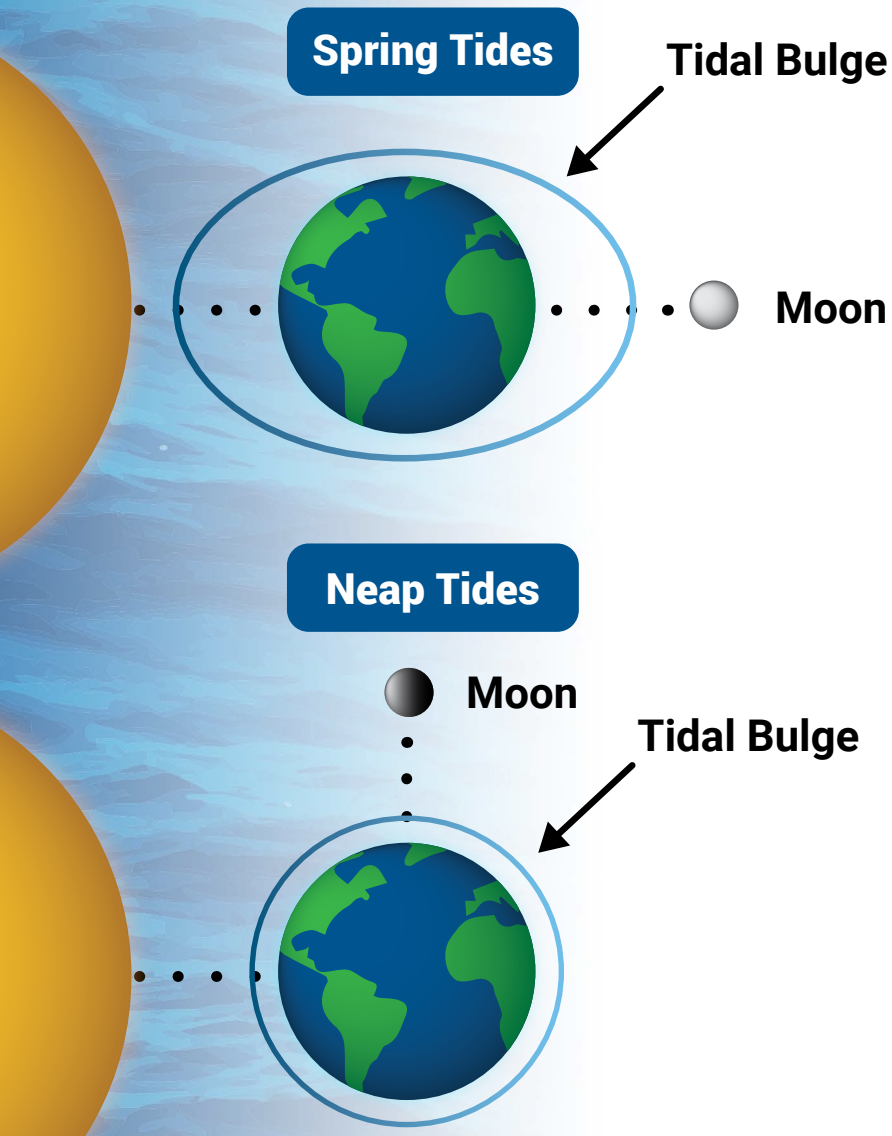


4. Plan the Full Mission in Detail and Have a Backup Plan

It is always important to have a plan before embarking on your mission. However, rough waters can be unpredictable so having one or two backup plans can save the mission if things go awry.

Go With the Tides

Get to know the tidal windows for the area you'll be working in and time your operations for as close to slack tides as possible. Slack tides occur during the short time when the tide is neither rising nor falling. During this period currents are usually at their weakest which can help make maneuvering your submersible easier.



Plan Around Spring and Neap Tides

Pay attention to spring tides and neap tides. Spring tides have nothing to do with the season. Instead, they occur twice each lunar month throughout the year. Spring tides occur over the new moon and full moon when the Earth, sun and moon are in alignment causing an increase in gravitational pull. This results in higher-than-average high tides and lower-than-average-low tides.

Seven days after the spring tide, the neap tide occurs. During the neap tide, the sun and moon are at right angles to each other. Because of this angle, high tides run lower than average and low tides run higher than average. Taking spring and neap tides into account can help with timing your operations to add valuable time to your operational window.

Time It Right

General tide times can be misleading depending on where you plan to execute your mission. Moving just a short distance from the port where the tide times are listed can change the slack water times by 30-60 minutes, so be ready to throw the robot in an hour before the quoted slack tide.

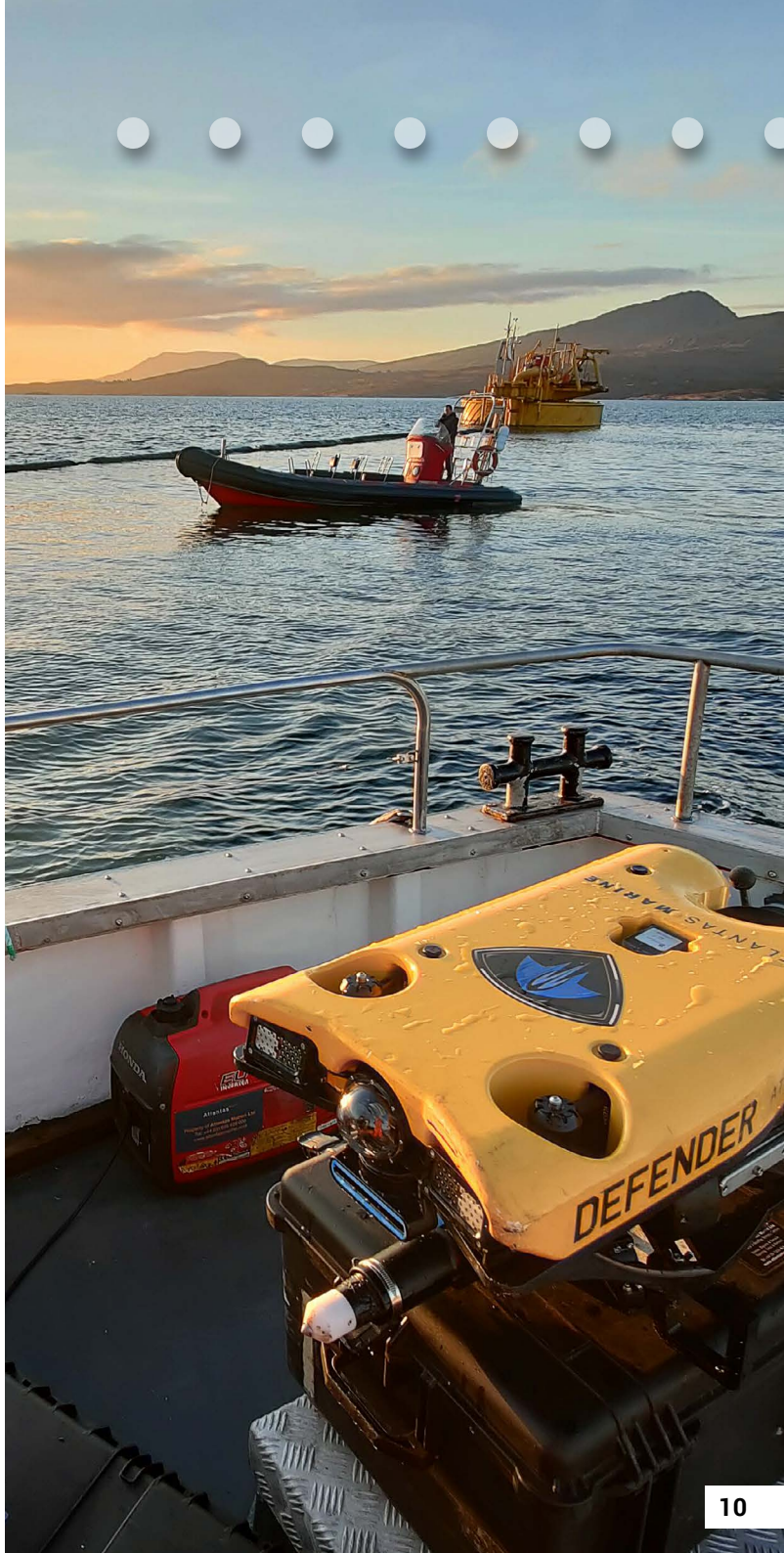
Depending on your environment, it may also be helpful to begin maneuvering your robot to the target area before the tide changes so work can immediately begin once the tide has changed. Sonar can also be used to find your target
as the vehicle makes its way down to its target.

5. Know When and How to Live Boat

Some missions may require you to deploy from a boat that is not anchored, this is called live boating. When live boating, run the system downstream, working it left and right, letting tether out as needed.

If you are working in a current greater than three knots, live boat with the engine facing upstream and deploy the robot from the bow downstream. Hold on to the tether and move the boat to position the system in the right spot.

Live boating can cause the vessel to move unpredictably, especially in rougher waters. Don't forget to be mindful of your tether's proximity to the rudder or propellers. As mentioned above, keep your tether as short as possible to avoid tangles.



6. Keep Lines of Communication Open Between Key Participants

Open communication is critical during any mission, but even more so when navigating heavy currents. It is especially important to maintain seamless communication between the pilot and the tether handler.

The tether handler should communicate to the pilot as the tether is deployed into the water—usually every 5 minutes. From there, the tether handler needs to be ready for the pilot to communicate what the handler needs to do. There is usually no time for delays.

7. Count the Turns in Your Tether

Pay careful attention to the amount of turns in your tether so you don't put torque on the system. This will make it difficult to fly but with awareness and skill, it can be overcome.

8. Know Your Tether Types

Tethers are available in different length strengths and buoyancy. Choosing the right tether and managing it can have a very significant impact on the outcome of an mission. This includes selecting the appropriate type of tether and managing the deployment and retrieval of the tether during operations.

A thinner tether has less drag but also has smaller conductors and less power transmission capacity. Selecting the right tether is a balancing act between performance and handling characteristics.

Tethers are available in negative or neutral buoyancy. Negative tethers sinks but has larger conductors, which means longer lengths can be used without affecting the power available to the system.

Neutral tethers are neutral in freshwater (slightly buoyant in salt water) but has thinner conductors. Neutral tethers are available in standard diameter and performance diameter (also called PPT), which is thinner.

Copper or fiber tethers are thinner than most other tether types but requires an onboard battery to maintain maximum power to the system.

VideoRay offers one negatively buoyant and two neutrally buoyant tether types to accommodate various conditions and configurations. If you're operating at depth, use a length of tether with a neutral PPT. It is thinner and will provide much less drag on the robot. Negative tethers can also be used, but too much in the water will drag down the robot.

VideoRay

9. If You Can't Beat It, Go With the Flow—Literally

Sometimes the best you can do is to position yourself upstream of your target and fly the robot like a kite in the stream. You will still have some limited lateral and vertical control to hopefully get within visual or sonar range of your target. Be soft in your wrist and tough in your flight. If you fly with fear or hesitation the current will win every time!

Try not to be in midwater if you don't have to be. If it's impossible, then sit on the seabed and use the camera and yaw function of the system.

To learn more about how VideoRay can help you optimize your underwater missions with subsea robotic systems, visit **www.VideoRay.com** or call +1 (610) 458-3000