Martha's Vineyard Coastal Observatory
2021: State of the Observatory Report

Executive Summary

The Martha's Vineyard Coastal Observatory (MVCO) is a critical facility of the Woods Hole Oceanographic Institution (WHOI), and has supported scientific and engineering research, education, and technological advancements since its creation in 2001. With both power and high-speed communication links to multiple offshore fixed platforms, MVCO is extensively used by WHOI scientific staff, outside collaborators from research institutions and national labs, and developing and established ocean industries.

The MVCO is internationally recognized as a cutting-edge research facility, and used locally on Martha's Vineyard as a public source of environmental information and a gateway into WHOI itself. With a recent upgrade of its sea cable, MVCO is poised to continue to serve the community well for the next decade and beyond. However, careful planning now for an end-of-service or revitalization/enhancement will both reduce near-term maintenance costs and, if desired, extend MVCO's service to the community for decades to come.

Outline

Introduction

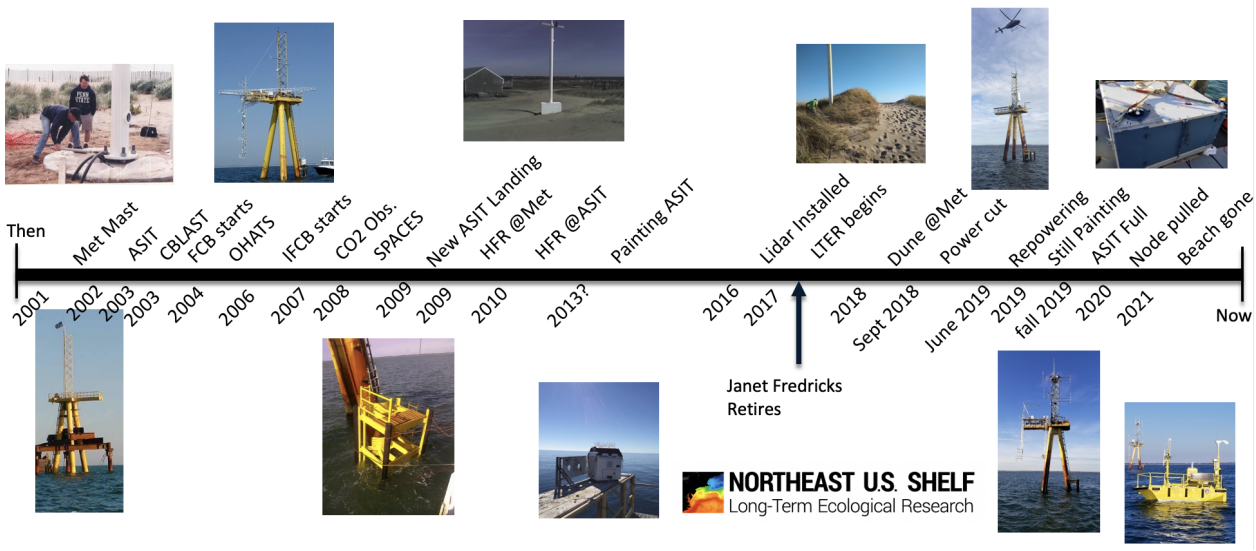
The Martha's Vineyard Coastal Observatory (MVCO) is a research outpost located along the south coast of Martha's Vineyard, MA and within the coastal ocean offshore. MVCO was created by WHOI scientists in 2001 to carry out sustained observations of the coastal ocean and atmosphere as well as to provide an infrastructure that could support future process studies of the marine environment. Led by Jim Edson and John Trowbridge, scientists within WHOI's

Applied Ocean Physics and Engineering Department, WHOI scientists and engineers worked to design, build, and commission the observatory throughout 2001 to 2003. Construction of the shore lab, meteorological mast, sea cable, and underwater node was funded by the National Science Foundation. Construction of the Air-Sea Interaction Tower offshore was subsequently funded by the Office of Naval Research. Since installation, MVCO has been maintained continuously by WHOI as a facility for basic and applied science research.

MVCO: The Assets

The MVCO has been used extensively for the past 20 years by WHOI science and engineering staff, outside collaborators from both research institutions and national labs alike, and developing and established ocean industries. Numerous research projects, big and small, have depended on the observatory for both a stable platform in the ocean and environmental data collection experience and expertise. Both single investigator and large multi-institution research efforts have utilized the facility: from the long running Flow CytoBot and Imaging Flow CytoBot deployments (2001-present), which now serve as an anchor point for the multi-decadal, NSF-funded, Northeast Shelf-LTER, the CBLAST-OHATS studies of coupled air sea boundary layers (2002-2004), the ONR-sponsored Ripples/Mine Burial Directed Research Initiatives (2003-2004), the ONR-funded acoustic communications project (SPACES: 2008), as well as long term monitoring by the NOAA Global Climate Change CO2 monitoring program (2008-

2018), and surface current monitoring via land and tower-based HF Radar installations (2009-present). MVCO has also served as a NASA AERONET program ocean color cal/val site (2003-present), and paired NSF/NASA funded testing of boundary layer parameterizations and satellite sensor validations (Edson/Farrar/Zappa 2019). Finally, since 2016 the site has hosted a suite of offshore wind energy industry-specific measurements and conducted wind energy sensor validations, making it an advanced outpost for scientific and technical development for this rapidly emerging industry in the U.S. Combined, these highlighted efforts --as well as numerous others not mentioned--have created a substantial (200+) list of MVCO-enabled scientific publications which span the full spectrum of oceanographic and ocean engineering disciplines. WHOI's own Imaging Flow CytoBot group, led by former MVCO Chief Scientist Heidi Sosik, has collected over a *billion* images of phytoplankton at the ASIT.



MVCO: A Timeline

This document summarizes the present state of the observatory, its use and usefulness to the scientific and engineering research community, and presents potential options for the future. A WHOI-focused open discussion of the observatory took place on Monday, April 12th, via an online meeting forum. A survey was conducted of interested users and community members, and statistics on the observatory's online use were gathered (Appendices C and D). Options for the future of the observatory were preliminarily vetted. These data were gathered and organized here to summarize the observatory's history, describe the present state of the observatory, and present viable options for the future, both near- and long-term.

This document should be used by WHOI to provide the scientific and technical justification for future planning or scoping studies to fully realize the institution's plan for the observatory in the future.

Scientific Goals and Mission

The goals of the Martha's Vineyard Coastal Observatory (MVCO) are to support the science and engineering needs of WHOI researchers and the larger scientific community by:

(1) serving as a platform, a power source, and a communications link for instruments sampling the coastal ocean, sub-bottom, and atmosphere; and

(2) collecting long-term observations of the atmospheric and oceanic environment that aid the science and engineering efforts of both local and remote users.

MVCO staff (Appendix A) seek to accomplish these goals via a focus on operations and maintenance of the observatory's infrastructure as well as careful and thoughtful support for the unique science mission and goals of each of the observatory's users.

History

The MVCO was created at the turn of the century, at a time when coastal ocean observing systems and monitoring programs via sustained, cabled, outposts in the ocean were exciting and popular. Newly enabled by technological, cable, and computer science advancements, these systems were deployed throughout the world, including: New Jersey, Japan, Ireland, Newfoundland, Panama, and Antarctica, as the potential for subsea cables with fiber optic communications offered long term, sustained observations, effectively unlimited power for sensors, high-speed communications, and a release from the dependence on mooring-based sensors and deployment cycles. In the years that followed, all except MVCO would cease operations due in part to technological obsolescence, but also due to limitations of design and the core science efforts pursued. In their wake, state-funded initiatives: NSF's Ocean Observing Initiative (OOI), Ocean Networks Canada, and the European Seas Observatory Network (ESONET) have come into fruition in the past decade. These major research construction projects have focused on using developed technology, turn-key operations, and outreach and extension to augment and further the scientific mission at their core.

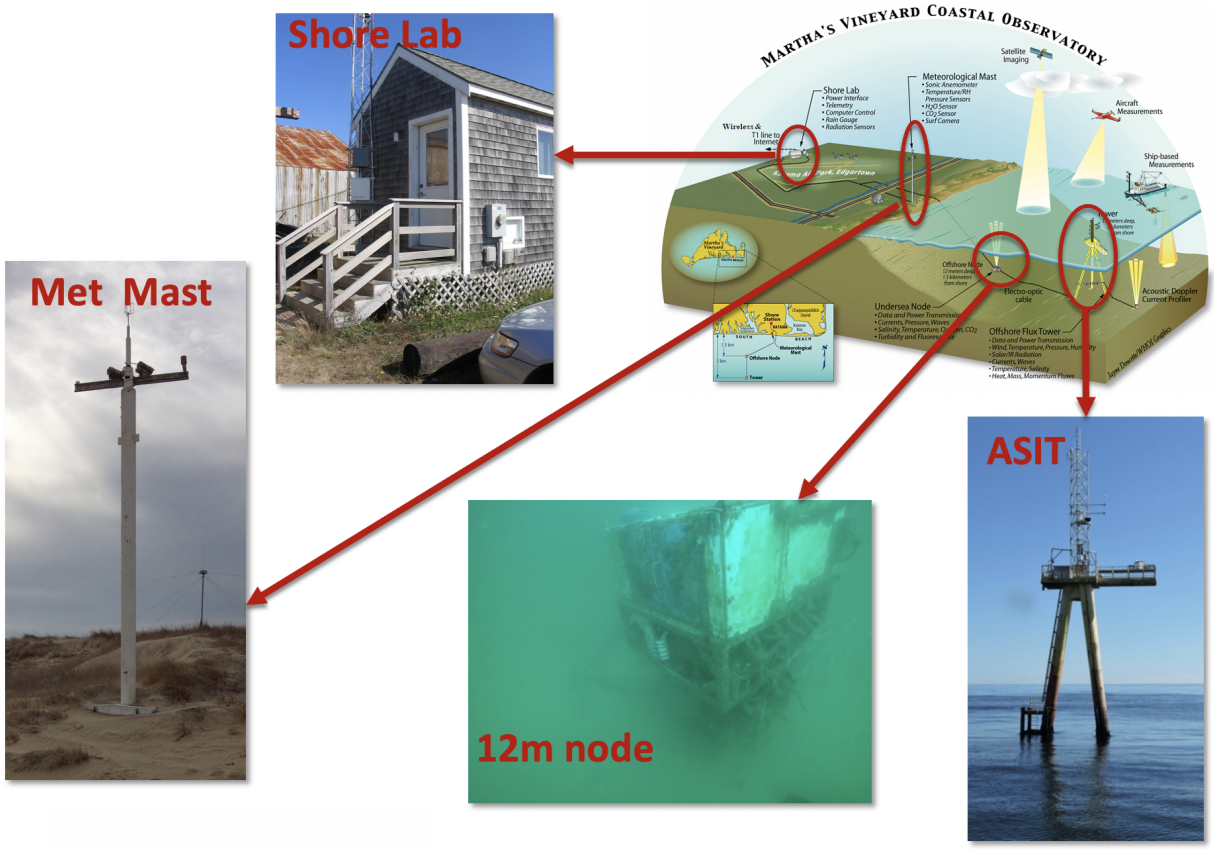
MVCO remains in operation, as a single institution-run coastal observing system, in part due to its unique modular power and communications design -- conceived and implemented at WHOI -- but also due to its diversity of platforms, all highly focused on supporting cutting-edge science, the diversity of supported research, and the dedication of the WHOI scientific and technical staff who have maintained it. At present, other deeper cabled observing systems run by single institutions exist (MBARI's MARS, The University of Hawaii's ALOHA) with pluggable nodes and fixed and user-contributed sensors, but MVCO stands alone in its longevity, flexibility, and durability.

How MVCO was built: Since its founding in 1930, WHOI has led the way in ocean observing system technological development, scientific justification, and operations and maintenance. The presently maintained Air-Sea Interaction Tower (ASIT), the largest piece of MVCO's

infrastructure, is not our first tower for studying the air-water interface (see below). The present MVCO was built with both ONR and NSF funds, and designed around a series of flexible power and communication ‘nodes’ that could be interchangeably placed throughout the observatory, thereby standardizing and simplifying how the observatory is run and maintained.

Observing Systems Past: The “WHOI Air-Sea Interaction Tower” in Buzzards Bay around 1962, in “Wind Waves” by Kinsman, 1965.

The Shore Laboratory, located at the Katama airfield in Edgartown is the starting point for the observatory’s fiber-optic power cable. It contains the computer systems and power supplies necessary for controlling the sensors and logging the data locally. The Shore Laboratory is connected to WHOI via a WHOI-run high-speed wireless radio network and a commercial-leased cable gateway as back-up. The laboratory includes an automatic backup-power generator to continue operation of the entire system during power outages. All computer and equipment operations can be monitored remotely from WHOI.



MVCO infrastructure

Cable description and installation: The main sea cable consists of a core of ten single-mode optical fibers contained in a loose-tube assembly at the center of a core of six AWG13 copper power conductors, with high voltage insulation. The core is jacketed with a polyurethane sheath protected by two layers of cross-laid armor wire and a polyethylene outer jacket. To cross the sensitive beach and dune area of South Beach State Park in Edgartown, WHOI contractors utilized directional drilling to install a steel conduit, 626 meters in length, between the airfield and the seafloor (approximately 300 meters from the beach in about 3 meters of water). A second conduit (206 meters in length) was drilled to provide a cableway to the meteorological sensor mast located at Edgartown's lifesaving headquarters on South Beach. The cables were then pulled back through each conduit and connected to a junction box on the airfield and then to the lab. The offshore cable was laid on the bottom, then jetted under the sand or peat using an underwater cable jet-plow.

The Sea Node: At the 12-meter isobath, approximately 1.5 km south of the Edgartown Great Pond, is the underwater instrument "node". The original node consisted of a 12" diameter steel pedestal jetted into the bottom with a four-foot square instrument frame sitting on top, which contained all the electronics for connecting the scientific instruments and sending the data back to shore as well as power transformers to step down power from the high voltage cable. Instrument deployments at the node were streamlined via diver-accessible mounting points, the

use of cables that could simply be plugged into an underwater connector to provide power, and two-way data communications from the instrument back to researchers on shore.

The Air-Sea Interaction Tower (ASIT): The Air-Sea Interaction Tower, completed in the summer of 2002, is located three kilometers offshore along the 15-meter isobath. Due to its design, the ASIT is the only fixed structure within U.S. coastal waters suitable for detailed studies of air-sea interactions and observations of the exchange of heat, momentum, and gases between the ocean and atmosphere. The tower was equipped with a similar 'node' providing power and two-way data communication to shore. In July 2003, a beam was installed between the two western legs to provide a platform at four meters below mean sea level for subsurface instruments (Appendix E). Top-side, users can access an instrumentation platform by climbing a ladder from the landing platform to the higher 'diving board' level, which is 12 meters above sea level. A 10-m met mast was mounted on top of this higher platform to provide air-side observations up to 22-m above sea level.

Continuous observations: Since its inception, the shore meteorological mast and ASIT have been continuously occupied, making observations for both short term, intensive oceanic and atmospheric studies as well as long-term monitoring of the marine environment for general scientific use. Data from the core sensors deployed on the ASIT are routinely ingested into NOAA's National Weather Service real-time datasets. The ASIT has served as a national test site for a wide swath of advanced oceanic and atmospheric sensors and sensing platforms since its commissioning. As an example, the ASIT hosted the first successful implementation of high frequency (HF) radar sensing of oceanic surface currents from a fixed, metal, offshore structure, as well as a number of underwater acoustics research initiatives. Researchers have utilized the facility for scientific studies focused on the coupled air-sea boundary layer, biological monitoring, as well as more recent efforts relevant to offshore wind energy.

Upgrades and developments: The observatory has undergone a series of upgrades and major maintenance operations since its creation. The individual nodes, both underwater and air-side have been regularly serviced and repaired, and much of the electronics have been replaced. The ASIT superstructure has been repainted multiple times. Larger upgrades include:

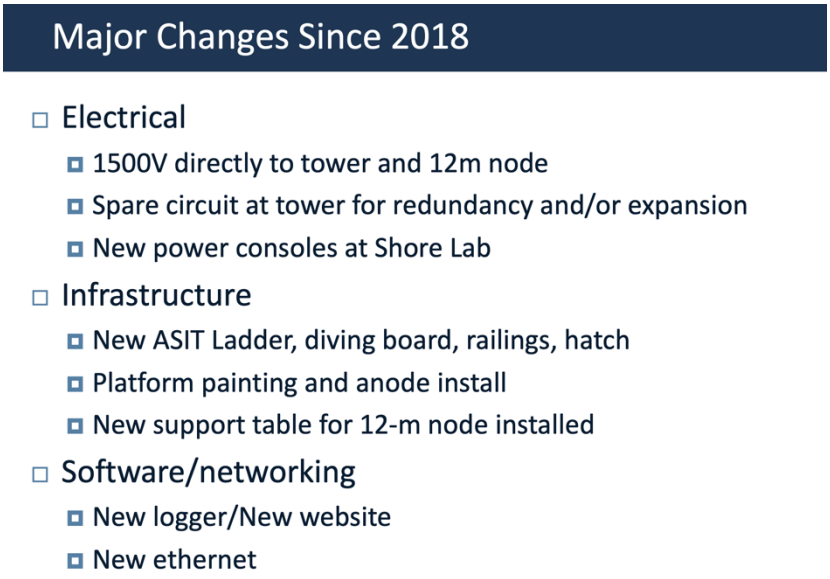
Platform upgrade: The ASIT landing platform was redesigned and replaced in 2009 to give a larger, safer landing pad for crew members to board the tower from service vessels. This also increased the weather window in which tower operations could be conducted.

The 2018-2019 overhaul: After 16 years of continuous use, the sea cables connecting the 12-m underwater node to the ASIT were in need of repair. Years of strong tidal currents and the pounding waves of winter storms had finally infiltrated the shielding of the cables near the ASIT, exposing the communications fibers and power-providing copper wires to the salty ocean. In the fall of 2018, two new cables were laid between the underwater node and ASIT. One, an extension of the main sea cable itself, allowed MVCO to streamline and advance the power and communications backbone of the observatory, and simplified future use and maintenance of the

cables and power structure. Issues with both the cable terminations and the revised power connections on the ASIT prevented repowering the observatory until May 2019. However, upon completion, the cable replacement dramatically improved the speed and reliability of power and communications at the ASIT, increased the amount of power available at the ASIT, and improved much of the shore-based support infrastructure, leaving the MVCO well-posed to support future science operations.

During this hiatus of science operations for the re-cabling, MVCO also replaced the superstructure of the platform that extends to the southeast (a.k.a. the diving board) to improve the safety of the facility, upgrade the instrument benches, and reduce its overall weight. Additional work replaced the personnel hatch, access ladder, and railings in order to upgrade these components to higher levels of workplace safety.

Software Backbone Upgrade (2020): Since the 2018-2019 re-cabling, the software behind MVCO has been completely redesigned and rebuilt. This includes the website, the data logger, and computer software that both supports user data collection and logging as well as remotely controls the power and communications switches that are at the heart of the observatory. These components support users' needs with a modern, robust automatic data collection capacity.



Present Status

Supporting the Science of Today: At present, the MVCO is a fully functioning observatory within WHOI, serving both internal and external scientific and engineering users. The MVCO is run by a staff of seven WHOI employees who spend approximately 14-person months per year contributing to the operation and maintenance of the observatory. Much of MVCO's operations are staged from the MVCO lab in Bigelow, but also from within the offices of MVCO staff located throughout the institution. Access to MVCO's offshore facilities is primarily done via WHOI's coastal research vessel, the R/V Tioga, of which MVCO is a primary user. A wider number of WHOI staff contribute to the operations of the observatory via focused efforts within their areas of expertise (i.e., dive operations, electrical work, machine shop services, or facilities). A list of the staff and contributors of MVCO, past and present, can be found in Appendix A.

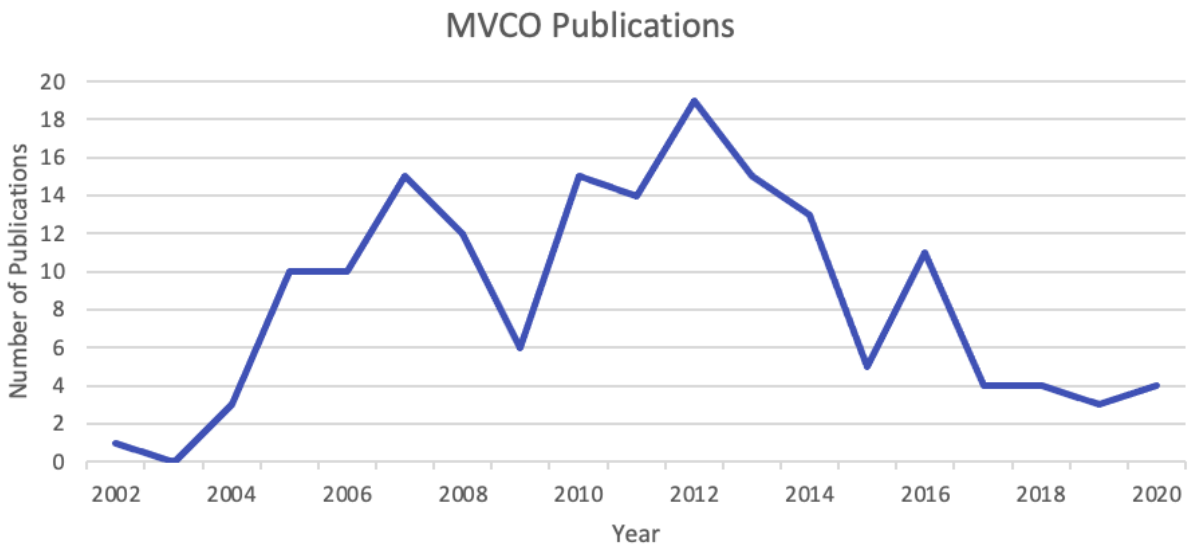
MVCO 'Core' Sensing Suite: Present Capabilities

Location	Sensor	Parameter Measured
ASIT	Vaisala PTU307	Air Pressure, Temperature, Relative Humidity
ASIT	Gill R3 Sonic Anemometer (East Facing)	3D Wind Speed and Direction
ASIT	Gill R3 Sonic Anemometer (West Facing)	3D Wind Speed and Direction
ASIT	Riegl Downward Looking Lidar *	Water Level and Wave Height Statistics
ASIT	Seabird 37 CT *	Water Temperature, Salinity, and Conductivity
ASIT	Nortek AD2CP **	Ocean Currents
12M	Nortek AD2CP **	Ocean Currents
12M	Seabird PAROS **	Water Pressure
12M	Seabird 19 CT **	Water Temperature, Salinity, and Conductivity
MET	Vaisala PTU307	Air Pressure, Temperature, Relative Humidity
MET	Gill Windmaster Pro	3D Wind Speed and Direction

** User supplied data sensor*
*** To be (re)deployed 2021*

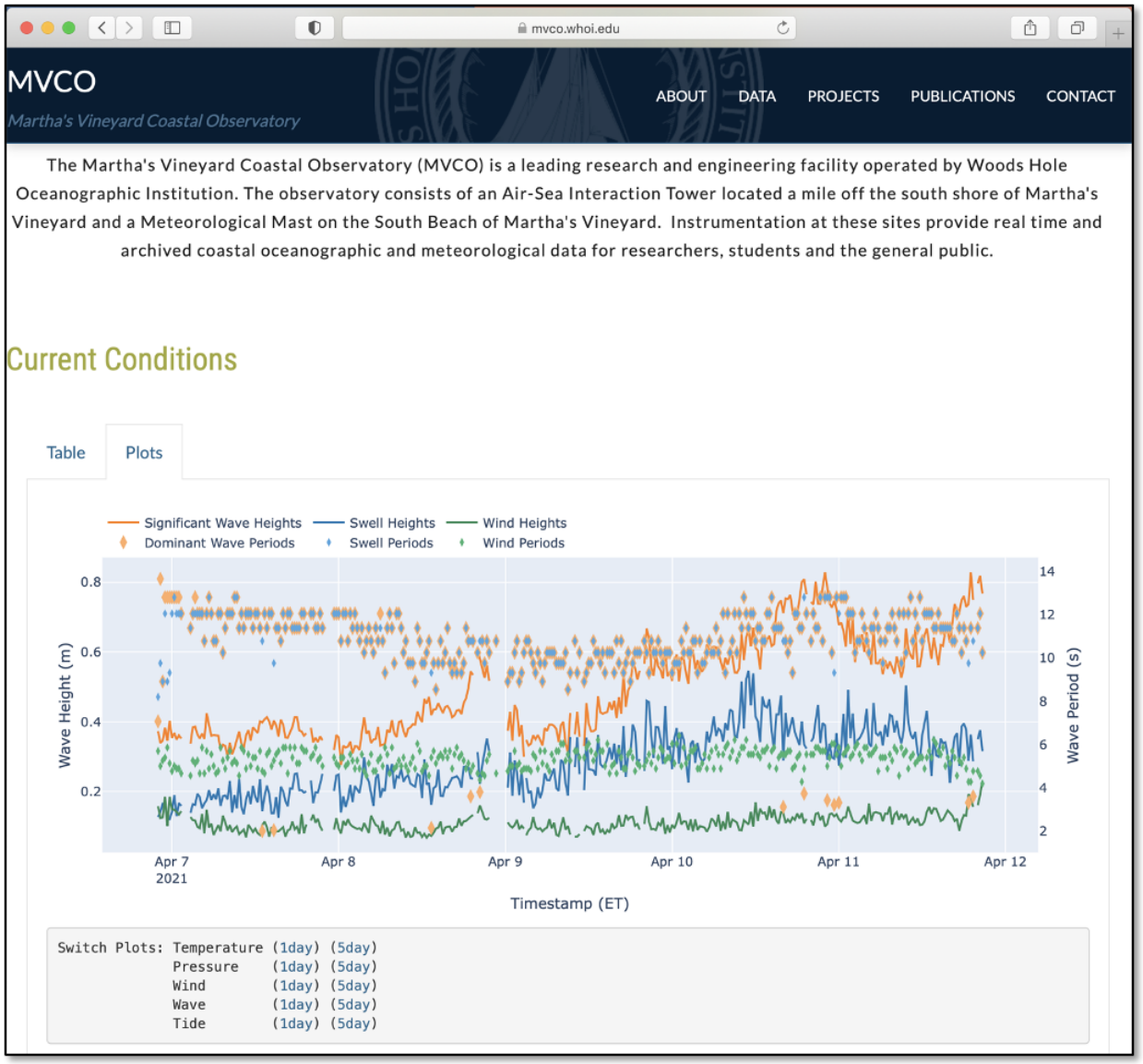
Currently, in addition to supporting the work of more than 10 individual users or project uses of the observatory, MVCO supports a consolidated set of core instrumentation to maintain a long-term record of air and sea conditions in the region. This record both serves as ancillary observations for MVCO users as well as provides a historical record that can be used by researchers more broadly to examine long-term trends in the local coastal oceanic and atmospheric climate. Observations from the historical record, starting in 2001 for some sensors, are freely available for download from the observatory's website (https://mvco.whoi.edu) and

Science or Engineering publications based on MVCO observations or deployments.



have recently been reorganized to increase usability. The historical record (Appendix B) of core sensors at MVCO are generally a quality-controlled version of the real-time observations collected and served with little delay on the MVCO website, both for public consumption of environmental information and engineering support for the observatory's operations.

Usage of the observatory can be documented via user numbers (given above), which translate into scientific publications (see above), but also the usage of the observatory's website for real-time information about the local environment. MVCO has collected statistics of the website's usage since late 2020, after completion of the revised 'current conditions' data displays. Since that time, MVCO's public website averages 35 unique visitors per day, with each user averaging 4 clicks each within the website. Most users view the front page with real-time data and camera images, and the plots or data results shown therein. A smaller subset of users actively



The re-designed MVCO website frontpage

download data, either from the real-time/past 5-day data feed or the historical record of observations spanning 2001-2018. More details on use statistics can be found in Appendix D.

Ongoing Maintenance Efforts: Maintenance of the observatory is ever-present. In the present year, staff are working to install new anodes on the ASIT below the waterline in order to protect the subsurface metal structure against corrosion. Work will also replace a cable pathway attached to the south leg used to secure instrument cables connecting underwater sensors placed on the sub-surface beam, and the communications node located top-side. A general inspection of the ASIT by an outside structural engineering firm will also occur this year. The 12-m underwater node will be repositioned this year, its deployment previously delayed due to COVID-19 vessel restrictions and damage to the underwater transformer's connection to the new node cable from ASIT. Onshore, cooling, power, and network upgrades at the Shore Lab have been completed that will increase reliability of the system.

Supporting the Science of Tomorrow: Current and near future use of the MVCO facilities is expected to be significant, and only slightly below the peak usage that occurred in the fall of 2019, when all of the node connections on the ASIT were utilized. In addition to serving as a continued anchor point for LTER and OOI for physical and biological sensing (IFCB, water sampling, etc.), a number of air-sea interaction studies, wave buoy validations, and acoustic communications testing are scheduled or proposed. Beach surveys at South Beach that rely on the Meteorological Mast-based observations are ongoing for 2021, and an expansion of the location's use as a base for HF radar sensing of the ocean's surface currents is expected.

Additionally, in recent years, MVCO and the ASIT have proven to be a valuable platform for both observations and advanced sensor testing for the rapidly emerging offshore wind energy industry. The ASIT will serve as a validation location for DOE-funded sensor development projects this year, and a recent award from the National Offshore Wind Research and Development Consortium (NOWRDC: primarily funded by the DOE and the State of New York) will continue the metocean observation campaign started in 2016 by the State of Massachusetts for at least the next 3 years, with an additional focus on conducting validations of wind industry-specific measurement buoys. This effort creates the first offshore wind energy Metocean Reference Site (MORS) in the U.S. at the ASIT. Finally, all of MVCO will support the DOE's next Wind Forecast Improvement Project (WFIP-3) field campaign, scheduled for 2023-2025, which will leverage WHOI's leadership in offshore observations in close coordination with researchers from the DOE's suite of national labs.

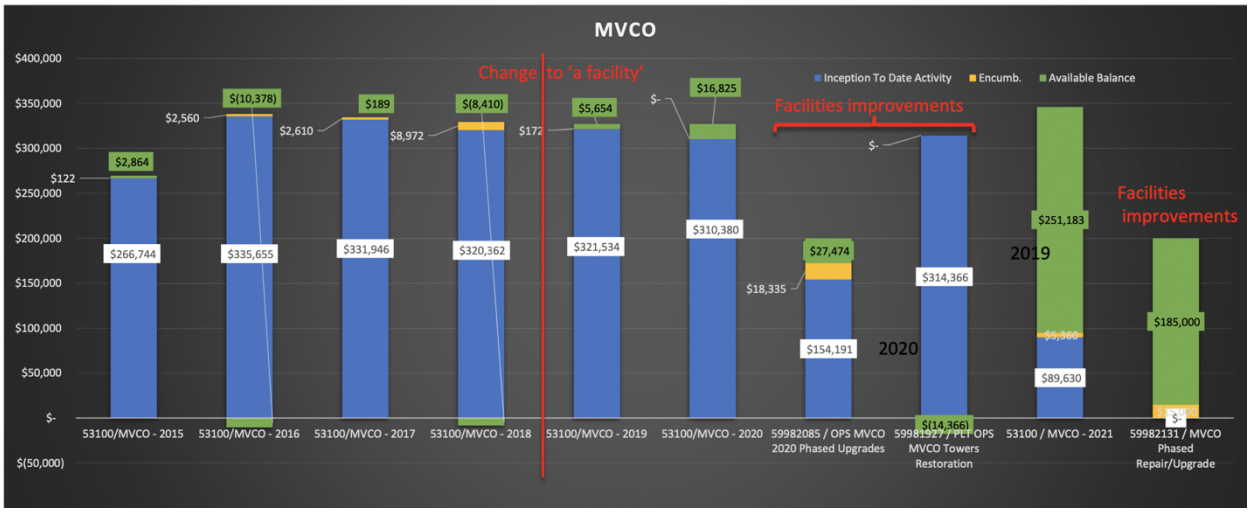
Funding and Support

After installation and the first few major programs, operations and maintenance of MVCO was run from a NOAA ocean observing center at WHOI (COSMOS) led by John Trowbridge and Heidi Sosik. Operations were funded by user fees (set prices for user connections of instruments and systems to the MVCO's nodes) as well as COSMOS yearly budget support

from NOAA. However, cost overruns were the norm, and user fees (e.g. ~$11k per year to plug into the ASIT) were never large enough to fund required maintenance operations. WHOI regularly supplemented the MVCO budget via internal unrestricted funds, with individual state awards for 'ocean technology'-type work used to fund upgrades that would maintain the power and communications infrastructure. It is estimated that MVCO's yearly budget was $200k-250k/year for the first decade, with ~$100k+ coming from unrestricted funds. It should be noted that the research funding for individual research projects, led by WHOI PIs, that utilized the MVCO during this time were significantly larger than these costs, which was used to justify the funding model for the observatory itself.

In 2015, WHOI transitioned MVCO away from 'user fee' funding and towards that of a cost center that was a 'facility' of WHOI, and funded from overhead or indirect costs. In this model WHOI would pay to maintain and run the facility (provide power and communications) and user projects would then pay for all costs associated with deploying or running their individual research projects (any required technical support, ship-time, or materials). As this was done via a larger number of separate accounts not controlled by MVCO, a full accounting of the external funding of WHOI staff for MVCO related-activities during this period, relative to the internal support for operations and maintenance, is not possible. However, in the present year (2021), we estimate that the 5 largest, known user projects will spend ~$250k in field support at WHOI (specifically: additional support required for MVCO staff, WHOI ship-time, materials and supplies) for carrying out MVCO-based projects. These amounts are separate from MVCO's operations and maintenance support, and additionally separate from direct 'research' funding (PI, or PI's tech support) for these projects which might be spent elsewhere at WHOI. A smaller number of user projects do not provide any direct support for MVCO, but share data with the observatory.

Focusing on the internal support for MVCO, operations and maintenance spending by MVCO staff for routine maintenance has consistently been ~$330k per year since 2016. The 2018-2019 re-cabling operation required an additional ~$1M. $700k in additional facilities spending



MVCO Finances 2015-present

(against the facilities bond) has come in the years since the re-cabling, as it was quickly realized that the infrastructure itself (primarily the tower) also needed improvements due to corrosion and safety. Setting aside the re-cabling, since 2015, WHOI has spent just under $3M ($2.953M) on operations, maintenance, and facilities improvements for the MVCO.

Near-term Challenges

Near term challenges, or risks, to the observatory's operations, and WHOI's support of them include the erosion of the beach proximate to the Meteorological Mast at South Beach State Park in Edgartown, the higher maintenance costs and reduced use of the 12-m underwater node, and corrosion at the ASIT.

At the Meteorological Mast, the northward migration of the coastline and dune over the past 20 years serves as both a significant drag on maintenance operations at the mast, and an existential threat to the mast itself. Shown most simply in the imagery seen here, note the position of the dune behind WHOI staff during the 2001 installation, and its encroachment on the mast itself now. At the present time, the mast base is buried under 6-7 feet of sand. Access to the communications and power node, located at the base of the mast itself, requires significant digging (required to be done by hand). At some point in the coming years (more likely 1-3 than 5-7), the mast will emerge on the south side of the dune and be exposed to direct wave action.

The base of the Meteorological Mast at South Beach State Park.

In the very near future, the mast will need to be removed. We estimate that the cost of removal will increase dramatically if the mast is allowed to emerge from the dune onto the beach.

At the 12-m underwater node, use of this asset for core data collection by MVCO has been consistent throughout its history. Use of the structure by internal and external users for the placement of additional sensors has been less so. The observations collected on the node by MVCO: ADCP-based velocity profiles, bottom pressure, and bottom temperature, salinity, and turbidity, were frequently used by science users, but the addition of other sensors to this node curtailed sharply after the initial research programs within the 2001-2008 period. The 12-m underwater node was carefully maintained over the historical period in part because it was a transition point for the sea cable itself, and critical to the infrastructure of the MVCO, but also because of the long historical record of core observations.

The new 12-m underwater node, ready for deployment...

One of the main goals of the 2018 re-cabling was to bypass the underwater node with the main power cable and bring the high voltage power line directly to the ASIT to decrease the complexity of MVCO's power system and by extension, the maintenance costs and down-time of the system as a whole. In the new configuration, the underwater node is now an offshoot of the main power distribution system located on the ASIT and not directly accessible from the shore lab. Thus, the 12-m node is no longer critical to the operations of the observatory as a whole. This reduced need and additional delays of equipment, sea-state, and COVID-19 restrictions contributed to keeping the underwater node out of the water since the re-cabling. The node will be installed this summer to support an on-going and also delayed acoustics effort, but its long-term future is less certain.

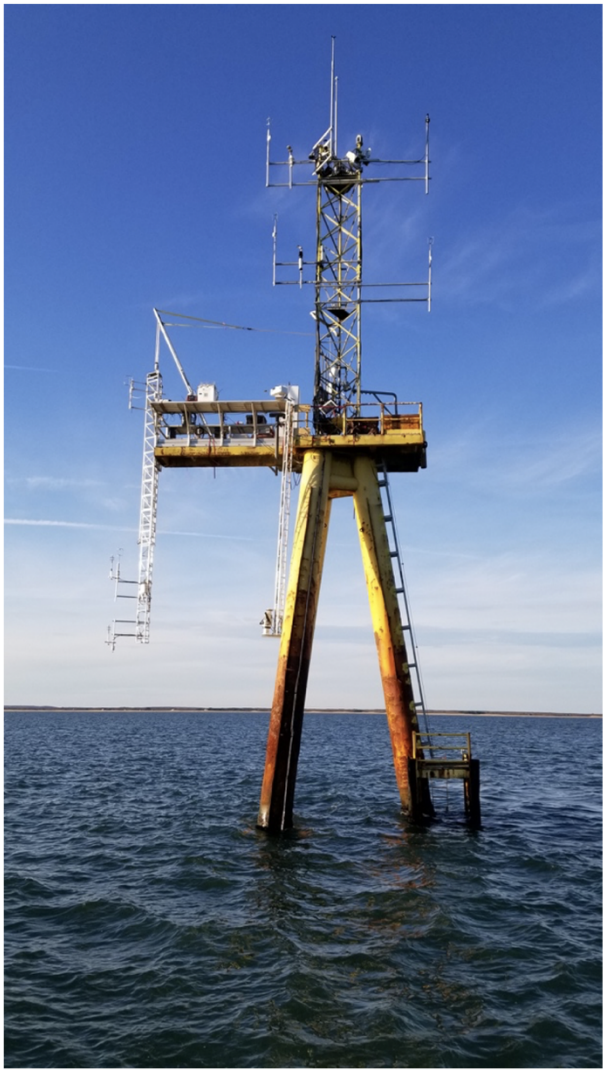
A secondary motivation for maintaining the underwater node has been to continue the long historical record at the site. However, due to the delays in re-installation, there is now a 3-year gap in the observational record at this location. To support increased use of the ASIT, MVCO is also moving to install a bottom mounted ADCP and CT at the ASIT itself, reducing the scientific justification for the 12-m node's continued support beyond this next deployment.

At the ASIT: Much, if not all of the recent and present spending on facilities improvements has been directed at the ASIT. This is for good reason, as it is both the largest piece of the infrastructure and the most heavily utilized. Contractors working for WHOI and MVCO have

recommended a number of maintenance operations, large and small, that should be conducted soon to ensure the structure is properly maintained. Some of the smaller activities, including:

1. subsurface anode installation,
2. periodic inspection,
3. replacement of the science cable flange on the southwest leg, and
4. spot painting of the superstructure,

are ongoing and/or planned for 2021. However, more significant efforts will be required to protect the tower legs in the intertidal zone and air zone from corrosion as well as ensure the superstructure (platform and met mast) continue to be functional for the long term. These 'bigger ticket' items are addressed more carefully in the next section, as the future use, occupancy, and projected lifespan of the tower are all critical to the decision-making process.

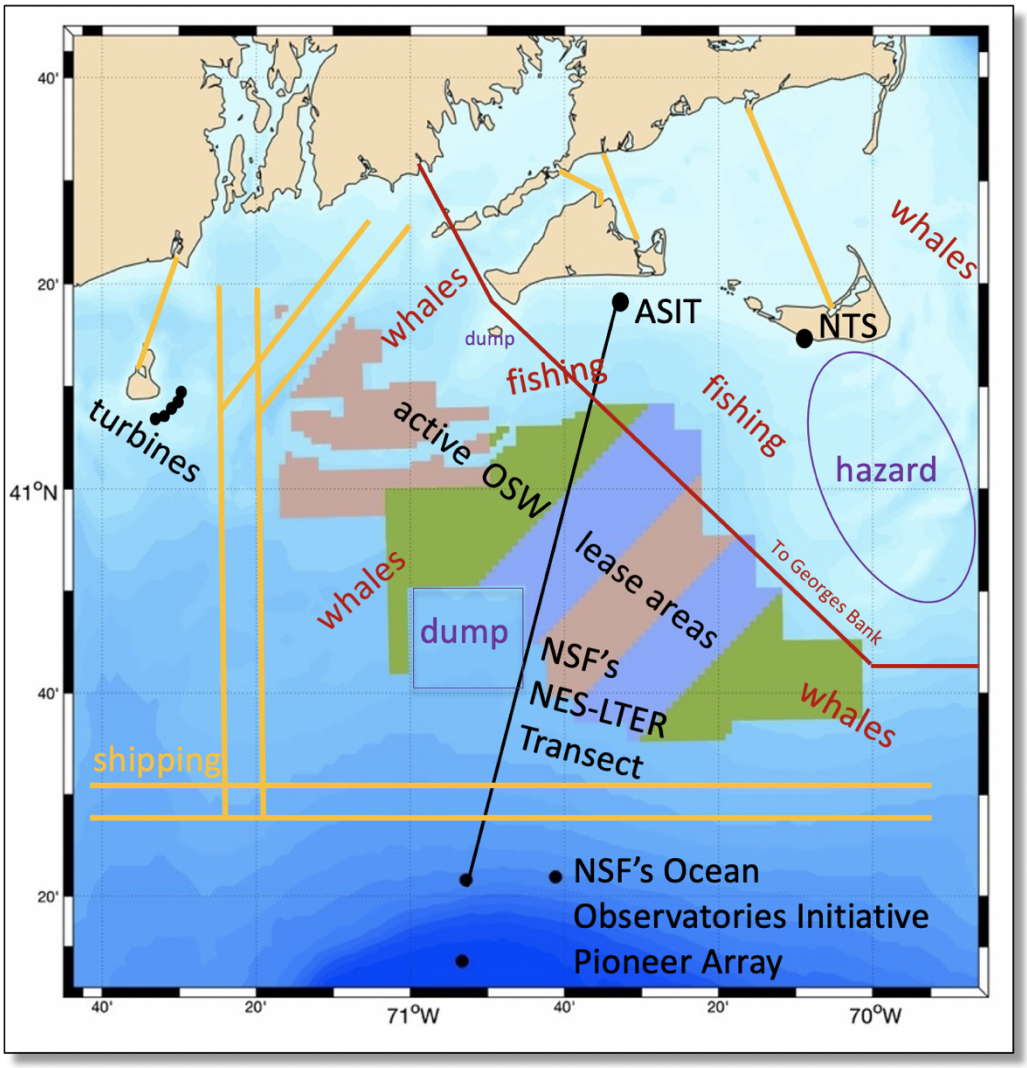


The ASIT during fall 2019, looking from the south with Martha's Vineyard in the background.

Long-term Perspective

The MVCO has been a critical piece of research infrastructure for WHOI scientists, engineers, and their colleagues over the past two decades. Similar to WHOI's ship operations, test facilities including the pressure test tank and the dock test well, seawater facilities, any of the numerous 'centers' within the institution (e.g. NOSAMS), the data library, or any of the 5 high-bays found around the institution, MVCO and its infrastructure are vital to a subset of the scientific and engineering staff. Not all WHOI staff utilize the observatory, but those researchers that do are successful, in part, because of the MVCO and the institution's support for it. In addition, MVCO serves as a public facing extension of the institution itself. Most of the use of the MVCO's website comes from the general public on Martha's Vineyard and proximate areas, which serves as a window into WHOI for these communities.

The coastal ocean south of Martha's Vineyard and Nantucket is not a pristine expanse, but a highly utilized and highly managed ocean environment. With local fishing interests, both commercial and recreational, shipping, boating and ferry traffic, remains of military activities of the past century, measurable and impactful regional climate change, and brand new, intensive ocean-based industries; the need for continued observational and monitoring outposts within the local ocean has never been greater.



A look at the activities in the ocean space around MVCO…

However, after 20 years of operations and aging infrastructure, WHOI must think carefully about the future of MVCO, both to chart a course for the observatory into the future, and to prudently use its institutional funds in supporting this critical piece of research infrastructure. Important information to consider includes:

- Users of the observatory (see Appendix C) appear to approve of the observatory's goals and historical and recent support for their research efforts. Suggestions for

improvements included an increased focus on extending core datasets, observatory 'up-time' and the potential of a science advisory committee for the observatory.

- MVCO's existing permit for 'use' of the coastal ocean with the state of Massachusetts, including the ASIT and underwater node, is set to expire in 2030. By the bounds of the existing permit, these pieces, particularly the ASIT, would have to be decommissioned and removed before that time. However, the ability to re-apply and extend the established permit exists.

- State waters in the area are designated as an ocean sanctuary, which is both a hurdle to the creation of infrastructure in the area and a justification for continued observation of the ocean environment from outposts like the MVCO within areas of sensitive habitat.

- It is likely that the strongest scientific support for a replacement to the meteorological mast at South Beach would be focused on observing surface waves, beach dynamics, and nearshore sediment transport. This would represent a distinct change in local focus for this component of MVCO's infrastructure, and could be modeled after the USACE's tower in Duck, NC with local optical and in situ observational assets. Strengthening interactions with USACE or USGS would likely be required to establish such a local focal point as a national center of research in the field.

- Careful planning for the long-term use of the ASIT is required now, both to guide the spending of near-future maintenance funds, and chart a plan towards an end-of-life date.

Recommendations:

1. Funds should be spent to plan, permit, and remove the existing meteorological mast at South Beach from its current location, and move MCVO's local infrastructure into a new shed behind the existing lifesaving station. The long-term focus of the site would change to supporting land based remote sensing, HF radar or land-based larger atmospheric sensors, in lieu of support for a replacement mast/tower, which should be scoped and evaluated separately from the removal action.

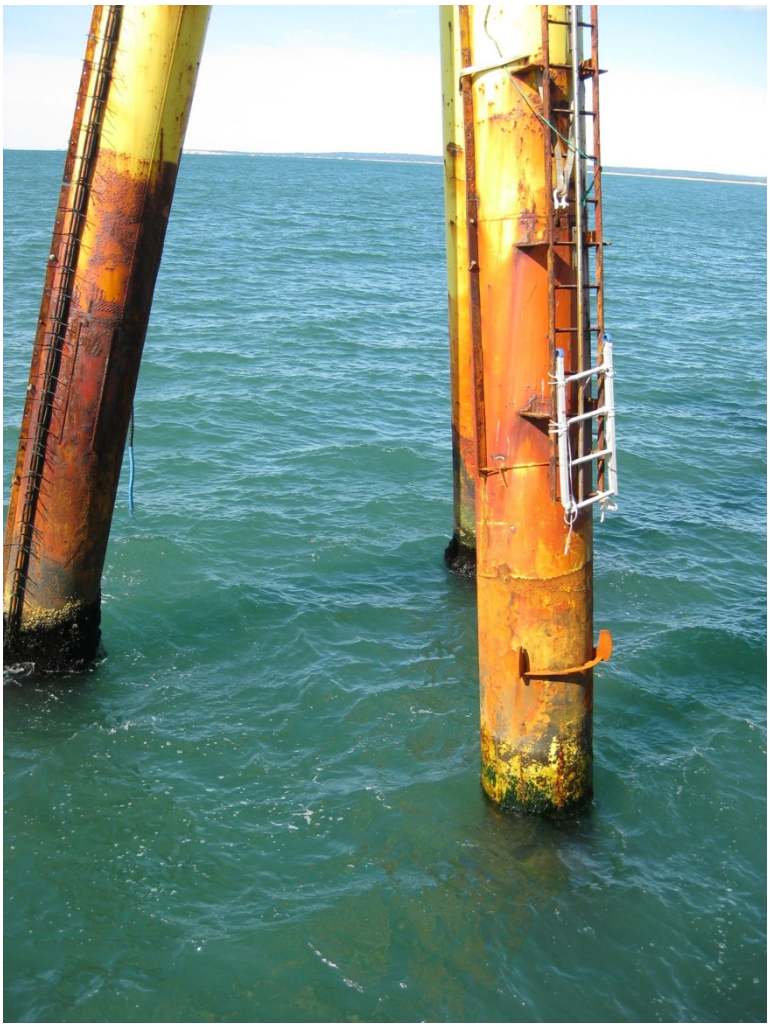
2. The underwater node should be transitioned, after this next deployment, to a 'deployable unit' if future users require its use. However, all core subsurface data collection should transition to take place at the ASIT.

3. A planning process to re-evaluate and choose an appropriate end-of-life date for the ASIT should be commenced as soon as possible, with a consolidated plan to emerge by the end of 2021. Consultation with the state of Massachusetts (via the offices of CZM, DCR, and CEC as well as the MassTech Collaborative) is recommended both for permitting visibility, science applications, and potential funding assistance.

Regarding (3) above, three distinct possibilities exist for the future of the ASIT, based on initial planning within MVCO in consultation with professional engineers and marine contractors. Each scenario answers the end-of-life date question in a different way:

(a) If we were going to tear down the ASIT in 2030 --the current permit end date-- what should we do differently now? Stop all significant structural maintenance operations of the ASIT, perform minor painting and corrosion protection at the platform level to increase safety in the near term. After 2025, inspections would need to increase in frequency with the likelihood of operations being successively curtailed over time due to safety concerns (e.g. no loads greater than 300 lbs on the diving board, or no access to the mast after 2027). Plan, and budget for a removal on or near 2030. This plan would likely result in significantly lower scientific use of the facility after 2025 due in part to increased risk of access and availability.

(b) What would make the ASIT a 50+ year observatory with the least amount of investment, extending past the current permit's end by 20 years or more? Spend ~$1M to: 'wrap' the legs at the intertidal zone to prevent additional corrosion, cut off and replace the diving board level platform and mast, repaint everything. This would give the potential for a taller structure, up to 35-40m above mean sea level, increase protection for the sea cable as it accesses the tower topside, allow for a larger central platform capable of supporting larger sensors, and allow for an improved access point for personnel to increase the sea state limitations of the operations on the tower. This would likely need to be done before 2024 to prevent excessive corrosion of the tower legs, which would become the key to the tower's lifespan. It is suggested that these improvements, most efficiently done all at once via a jack-up barge positioned onsite, would reduce out-year maintenance costs and increase availability and use of the structure through 2050.



The ASIT legs in 2009, during the landing platform replacement operation.

(c) What would give the ASIT/MVCO the possibility of even longer operations (70+ years)? Removal and Replacement. Estimated cost of replacement with a similar sized structure, based on a recent proposal effort, led by J. Edson, was ~$10M. This path would follow *option a*, above, initially with a planned replacement effort in 2025 or soon thereafter.

Additional details of each of these potential alternatives would need to be solidified within an observatory-wide facilities planning process.

Appendix A: MVCO Technical Staff

A long list of scientists and technicians have worked on MVCO since its construction in 2001. The list of staff and contributors is presented below, along with their role:

MVCO Staff	Role
Current Staff:	
Anthony Kirincich	Chief Scientist
Eve Cinquino	Coordinator
Jay Sisson	Mechanical Engineer
Steve Faluotico	Electrical Engineer
Hugh Popenoe	Electrical Engineer
Sidney Batchelder	Data Administrator
Eric Bates	Network Administrator
Former Staff:	
Heidi Sosik	Chief Scientist
Jim Edson	Chief Scientist + Co-founder
John Trowbridge	Chief Scientist + Co-founder
Zoe Sandwith	Coordinator
Janet Fredericks	Director
Marga McElroy	Logistics Coordinator
Mike Purcell	Mechanical Engineer
Tom Austin	Electrical Engineer
Andy Girard	Electrical Engineer
MVCO Contributors:	
Giorgio Caramanna	Diver
Ed O'Brien	Diver
Joe Fellows	Diver
Kim Malkoski	Diver
Glenn McDonald	Diver
Fred Thwaites	Diver
Danik Forsman	Diver
Alexi Shalapyonok	Diver
Pat Lohmann	Diver
Scott McCue	Diver
Jared Shwartz	Diver
Steve Caldwell	Engineering Assistance
Ed Hobart	Engineering Assistance
Isaura Weddige-Welch	Finance
Ann Stone	Finance
Richard Galat	Finance

Leah Houghton	Local Support
Pete Collins	Ship Support
Jim Missios	Ship Support
Ken Houtler	Ship Support
Ian Hanley	Ship Support
Dave Olmsted	Ship Support

Outside Contractors:

Matt Bumpus	Facilities Supervisor/Diver
Ben Karson	Facilities Supervisor/Welder
Jack Dacey	Facilities Contractor
Grady Reilly	Facilities Contractor
Scott Way	Facilities Contractor
Samuel Bumpus	Facilities Contractor
Forrest Ferrill	Commercial Diver
Mike Ferrill	Commercial Diver
Woody Ferrill	Commercial Diver
John Demassi	Commercial Diver
Craig Sams	Principal Engineer
Mike Ryan, Ryan Marine	Ship Support

Appendix B: Available Data in the Historical Record

A wealth of data is available within the MVCO's historical record, both from core, observatory collected, sensors as well as user collected data that was shared with the MVCO. Many of the simpler data sets are represented below, by sensor type, location, and year, in terms of the amount, in MB, of data available.

Core Data

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	InstTotal
Water Currents	12m	6MB	20MB	23MB	17MB	23MB	22MB	24MB	24MB	25MB	25MB	25MB	24MB	22MB	26MB	25MB	19MB	19MB	17MB			387MB
Summary Data	12m	1MB	2MB	2MB	2MB	2MB	3MB	3MB	3MB	3MB	3MB	3MB	3MB	2MB	3MB	3MB	2MB	3MB	2MB			43MB
Water Pressure	12m	705kB	1MB	1MB	952kB	1MB	1MB	1MB	1MB	1MB	1MB	1MB	1MB	1MB	1MB	1MB	732kB	1MB	601kB	991kB		21MB
Temperature, Salinity	12m		721kB	2MB	1MB	1MB	2MB	2MB	2MB	2MB	570kB	1MB	3MB	2MB	2MB	1MB	2MB	3MB	2MB			30MB
Temperature, Salinity	12m							1MB	1MB	961kB	322kB	582kB	1MB	1MB	1MB	759kB	1MB	1MB	883kB			12MB
P/AT/RH	asit				1MB	2MB	2MB	3MB	355kB	3MB	3MB	3MB	2MB	9kB								21MB
Temperature, Salinity	asit				307kB	680kB	599kB	165kB	3MB	2MB	3MB	3MB	1MB				318kB	2MB	2MB		871kB	20MB
Wave Height	asit																				1MB	1MB
Sonic Anemometer	asit				1MB	2MB	2MB	3MB	368kB	3MB	4MB	3MB		2MB	4MB	3MB	1MB					28MB
East Sonic Anemo.	asit																				1MB	1MB
West Sonic Anemo.	asit																				1MB	1MB
Summary Data	asit																702kB	11MB	11MB	9MB	11MB	42MB
P/AT/RH	asit					539kB	1MB	2MB	271kB	2MB	2MB	3MB	2MB	9kB	2MB	2MB	2MB	2MB	2MB		2MB	26MB
Cup Anemometer	asit																157kB	3MB	4MB		1MB	8MB
Sonic Anemometer	met	2MB	4MB	3MB	3MB	3MB	2MB	921kB	4MB	4MB	3MB	3MB	3MB	3MB	588kB	3MB	3MB	2MB	2MB		1MB	48MB
Sonic Anemometer	met	2MB	3MB	241kB																		5MB
P/AT/RH	met	2MB	4MB	4MB	4MB	4MB	4MB	4MB	4MB	4MB	2MB	4MB	4MB	4MB	4MB	4MB	4MB	3MB	3MB			64MB
Summary Data	met	2MB	4MB	4MB	4MB	4MB	4MB	4MB	4MB	4MB	4MB	4MB	4MB	4MB	4MB	4MB	4MB	4MB	3MB			67MB
P/AT/RH	met	1MB	3MB	2MB	2MB	3MB	3MB	2MB	3MB	2MB	2MB	2MB	2MB	3MB	3MB	3MB	3MB	1MB	2MB		2MB	43MB
		18MB	41MB	42MB	37MB	46MB	46MB	50MB	49MB	57MB	54MB	56MB	50MB	45MB	50MB	49MB	43MB	55MB	50MB	9MB	21MB	868MB

User Data

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	InstTotal
Temperature, Salinity	12m						519kB	791kB		761kB	2MB	2MB	1MB							8MB
PH	12m															353kB				353kB
Temperature, Salinity	12m							988kB	2MB											3MB
PH	12m														718kB	2MB	2MB	2MB		7MB
Temperature, Salinity	12m	3MB	139kB																	3MB
Air P/T/RH	asit				953kB															953kB
Visibility	asit										422kB	1MB	1MB	193kB	228kB	621kB	902kB	516kB	337kB	6MB
Aerosols	asit	2MB	3MB	315kB																5MB
Transmissometer	asit						1MB	484kB												2MB
Transmissometer	asit						252kB	617kB												869kB
Wave Height	asit				1MB	1MB		294kB	24kB											3MB
Chlorophyll	asit								3MB	2MB	3MB	3MB	1MB							11MB
Chlorophyll	asit								244kB											244kB
Transmissometer	asit						130kB	32kB												163kB
2m Temperature, Salinity	asit					804kB	376kB	2MB	258kB	1MB	2MB	2MB	2MB							11MB
8m Temperature, Salinity	asit					947kB	453kB	2MB	326kB	2MB	3MB	3MB	2MB							13MB
14m Temperature, Salinity	asit					545kB	370kB	1MB	273kB	2MB	3MB	3MB	2MB							11MB
Temperature, Salinity	asit					843kB	393kB	2MB	302kB	2MB	3MB	3MB	2MB							13MB
		4MB	3MB	315kB	2MB	4MB	4MB	10MB	6MB	9MB	17MB	17MB	12MB	193kB	946kB	3MB	3MB	2MB	337kB	99MB

User data has not been published by MVCO since 2018

Appendix C: 2021 State of the Observatory Survey, User Survey Results

The goal of this survey was to assess the usefulness of Martha's Vineyard Coastal Observatory (MVCO) to the scientific community. This survey complemented a 'State of the Observatory' discussion, scheduled for noon on Monday April 12th, which was open to all members of the WHOI community.

Survey instructions:

MVCO was created in 2001 to carry out sustained observations of the coastal ocean and atmosphere as well as to provide infrastructure to support process studies of the marine environment and instrument and sensor testing. After 20 years of operations, the observatory is reassessing its science and operational goals to ensure it can best serve the research community in the future. Please answer the following questions to help MVCO review its scientific mission and develop an operational plan for the next decade. External users are welcome to complete the survey as well.

Question 1:

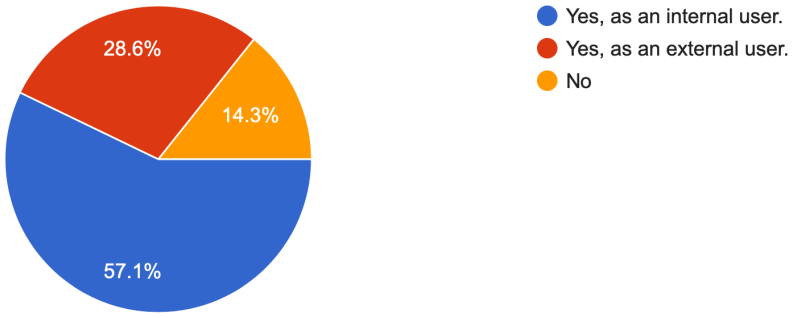
Are you currently an internal or external user of MVCO (i.e. you have used the facility or its data in your research anytime since 2019)?

14 responses

Question 2:

Have you used MVCO in the past, at any time before 2019?

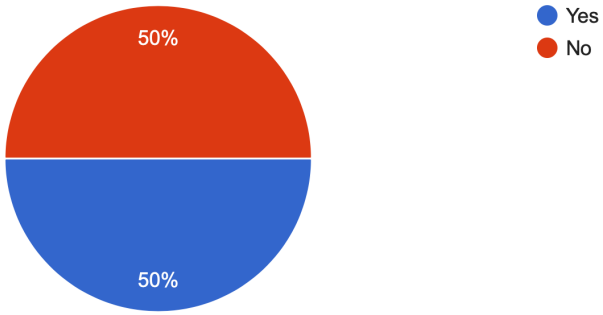
14 responses



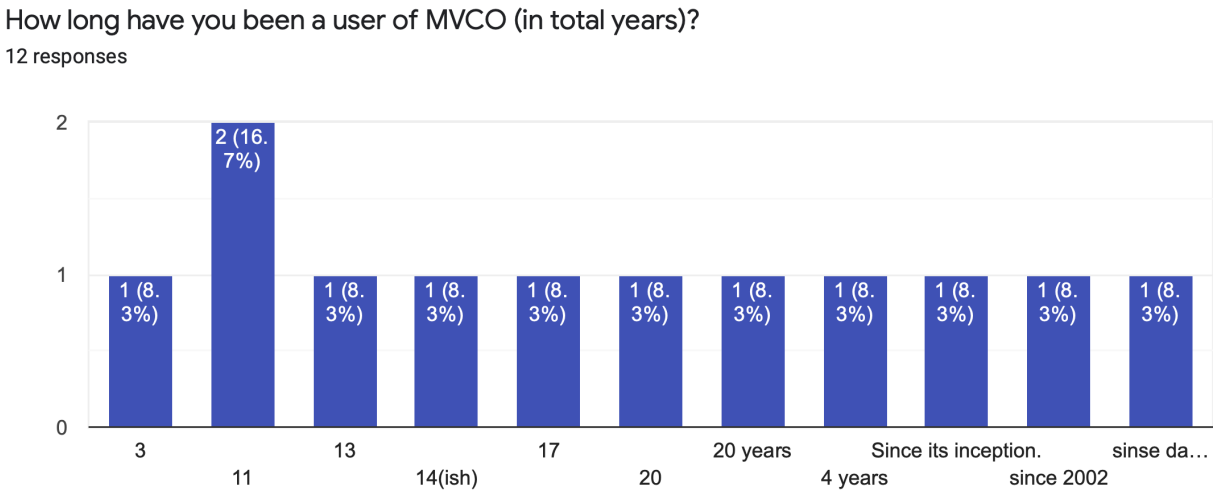
Question 3:

Do you use the MVCO website's pages showing the current conditions either for recreational or scientific purposes?

14 responses



Question 4:



Question 5: If you are, or have been, an MVCO user, please describe your use of the observatory facilities or data.

- Connected underwater instruments and use long term time series of waves and currents
- I maintain the observatory infrastructure and scientific needs
- HF radar platform
- Measurement of bottom currents with MAVS tripod
- co-PI on NSF (shore station & node) and ONR (tower) construction awards. co-PI for CBLAST and OASIS projects.
- High frequency radar operations
- I have had various sensors on the tower in water and a profiling system carrying a VPR and other sensors. I am interested in continuing to use fairly high bandwidth sensors (GigE).
- constant use of facility with minimal interruptions
- data analysis with ASIT lidar
- Years ago I used MVCO data in teaching. More recently in research.
- Work in the Sosik lab to deploy instruments and analyze data from MVCO
- Performed numerous field campaigns from ASIT, most recently from September 2019 through March 2020. I continually utilize MVCO/ASIT data for proposals and experiment baseline.

Question 6: MVCO lists publications that have used the facility at https://mvco.whoi.edu/publications/ . Which of your publications have we missed?

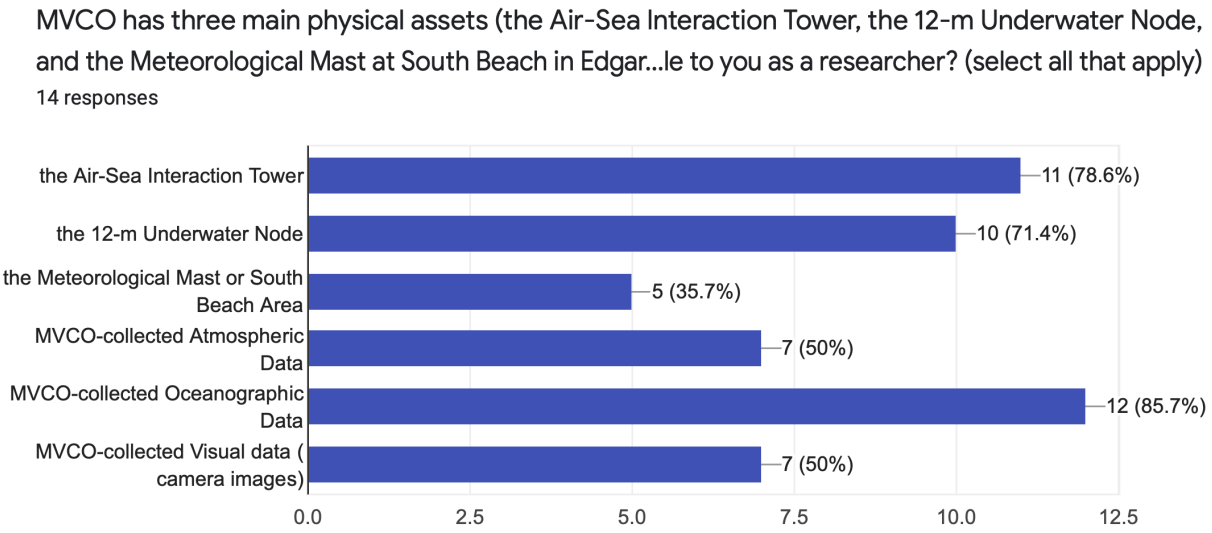
- Will check
- https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2020JC016368

- None missed
- None.
- none
- My paper is there!
- doi:10.1175/BAMS-88-3-341; doi:10.1029/2006JC003947;

Question 7: How might you hope to use MVCO's facilities or data in the future?

- Use long term and real time time series of waves and currents
- Provide infrastructure upgrades to prolong observatory lifespan for scientific uses.
- continue to use as HF radar platform
- None, now retired
- No immediate plans.
- Interested in Air/Sea interaction studies using ASIT
- Wind Farm construction and evaluation of habitat and its change over time requires in place sensor packages for long term monitoring. MVCO is valuable in this context because of its historical context and continuing real-time data sets. Going forward I would like to add several sensor packages to the 12 m node or tower arm for plankton and passive acoustics based on DOE and funding directly from Orsted. I would also add underwater cameras for fish detection with real-time deep learning classification.
- continue constant use as long as it lasts
- in teaching and research
- Continue to use ASIT for field campaigns.
- There has been discussion recently at a WHOI Aquaculture Research Planning workshop about developing a "test bed farm" for offshore aquaculture research. There may be advantages in siting such a "farm" for seaweed and shellfish culture research near MVCO, sensoring it for real-time relay, and monitoring its interaction with the environment.

Question 8:



Question 9: MVCO has the dual goal of providing sustained observations and maintaining research infrastructure, both of which should directly support the research efforts of the WHOI community and our external colleagues. How well do you think MVCO has achieved these goals over the past 2 decades?

- Pretty Well
- Goal achievement has been outstanding in light of the annual funding support
- The observatory has performed well.
- Very well
- Very well.
- very well
- It seems like it has done a good job. It would be great if there was a better way to track data users (perhaps a DOI through WHOI's data library), and even a public code repository to share any of the processes used to make data products.
- Variable. The main problem has been the cable and loss of multi-fiber high bandwidth communications. When that is returned I think use will return.
- reasonably well
- I am mainly interested in the sustained observations. This has been good for many types of observations, as evidenced by the (nicely laid out) webpage for historical data. However, there has been a disruption in sustained observations since 2018.
- It is a remarkable facility.
- Reasonably well. The sustained observations have been valuable as a continuous time series as a baseline for coastal processes. I think the latest upgrades to the ASIT have been long overdue, but were just in time for my latest field campaign. ASIT would not

have been able to support this if not for the upgrades, specifically to the power and fiber optic to shore.

Question 10: Should the observatory's goals be revised or expanded? What do you think the primary goal of the observatory should be moving forward?

- I think the combined goal of platform and long term and real time observations is good. real time was not emphasized in Anthony's talk ,but seems very important to me
- The current goals are sufficient
- providing a stable platform for oceanographic measurements
- Monitoring coastal processes
- It seems like there are potential avenues to expand public outreach around the tower
- long-term monitoring with real-time data presentation
- maintaining research infrastructure
- I think the dual goal of sustained observations as well as research infrastructure (in particular the offshore tower) may become even more important as wind energy gets developed south of MV. (In other words, I think keep the dual goal / no need for revision or expansion.)
- I think continuing all of the aspects are important. In the meeting someone noted it could possibly do more with social media/outreach. Since we don't have fish images, maybe IFCB phytoplankton images would also be interesting! There could be a screen shot of the whole dashboard mosaic, or individual images.
- Continue to support the MVCO.

Question 11: What could MVCO and its staff be doing to better serve your research needs?

- More and better beach infrastucture. Stereo cams to monitor erosion. See https://www.usgs.gov/centers/pcmsc/science/remote-sensing-coastal-change?qt-science_center_objects=0#qt-science_center_objects. We are unique because of the offshore forcing measurements
- no comment
- Keep it going
- The atmospheric side is fantastic. It still feels difficult to support a number water-side studies that need to avoid flow disturbances around the tower structure. I also realize this is a large task, and may be beyond scope.
- I have been waiting for several years to add a plankton sensor that requires GigE coms. I am ready to add this sensor whenever GigE is available.
- better communicate upcoming activities, develop user friendly tools for GPs and instruments controls
- Providing data since 2018
- Always have good communication about trips to the tower, so that there is sharing and collaboration as much as possible. Also, the turning on and off of power to ports really

needs to have a GUI for users to do themselves and not depend on MVCO staff (as was the case previously). Sometimes there is a need to power cycle instrumentation off work hours etc.
- Within the last few years, the continued upgrading and maintenance of MVCO/ASIT was stellar. And the support was top-notch.

Question 11: Maintaining observations and research infrastructure costs money. The funding model for MVCO has evolved over time into one where WHOI pays for the maintenance of the observatory, as a facility of the institution, and individual users pay for the access and services required to carry out their individual research plans. Please provide feedback on this model, our execution of it, and its appropriateness for the goals of the observatory and/or WHOI.

- Maybe should try to find some additional outside source as a state or national facility
- The funding model itself is just fine. More money is necessary however, to support observatory maintenance, and needs to be a full time effort.
- no comment
- Good model
- This seems to be the model that works.
- Not a current user, so unsure how to comment.
- I think this present plan works well. WHOI should continue to maintain infrastructure while individual projects pay for access.
- don't have enough information to comment
- This sounds appropriate; however I am wondering about MVCO facility core data - will MVCO core data be accessible without fee?
- I think this is an solid model now and for moving forward.
- It would be useful to be able to review a list of these costs for consideration of possible projects. It would also be useful to know how often WHOI boats are going to the site, and whether there are opportunities for pooling costs with other research projects and needs.

Comments: Please provide any other comments you might have here.

- Tower access is very limited owing to weather conditions, impacting productivity. Making an effort to explore alternative solutions to improve this access in more adverse conditions would be a good idea. Perhaps reaching out to oil companies, or similar, would be a worthwhile effort.
- This is Scott Gallager and I would like to know who to speak with for adding sensors. Thanks.

- I thought the topic of how much it would cost to take it down was interesting - in conjunction with how much it costs to keep it going. It seems like such a special and unique observatory -already with a 20 year history. Keeping it going as long as possible seems like a cost that should be able to be justified. Not only that - if it's lifetime comes to a close - we have the experience and the history - it shouldn't just end, but get a replacement platform. I had a question about the met mast. I thought the wireless from the tower to the met mast was an important form of back up communication. Or is that no longer the case? I was thinking how this would be affected when we have to move or take down the met mast. Thank you so much for all that you do.
- If not already in place, I think it would be worthwhile to have an external advisory board or committee that would be able to engage in more specific discussions to the above questions, and more generally overall for the health of MVCO as a scientific resource for the broader community.
- Not sure why this is anonymous. Any questions - slindell@whoi.edu

Thank you so much for your feedback!

Appendix D: 2021 MVCO Website Usage Statistics

Since completion of the revamped MVCO website in late 2020, MVCO has tracked usage of the site and its contents using Google Analytics. These statistics have been aggregated to provide insight into how often users are accessing the MVCO website, how much data or information they access, and where they are coming from.

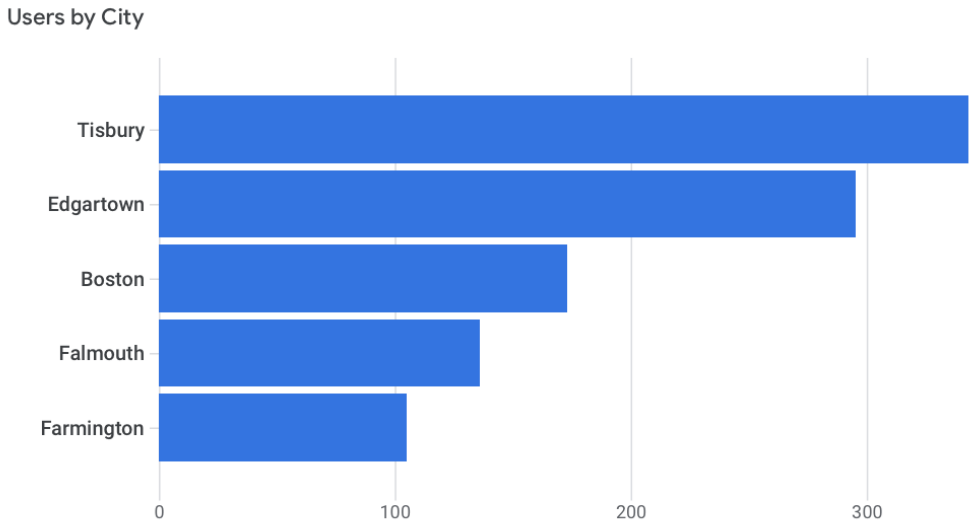
Since the start of record-keeping in late December, 2020, ~2300 unique users have visited mvco.whoi.edu:

Search... Rows per page: 10 Go to: 1

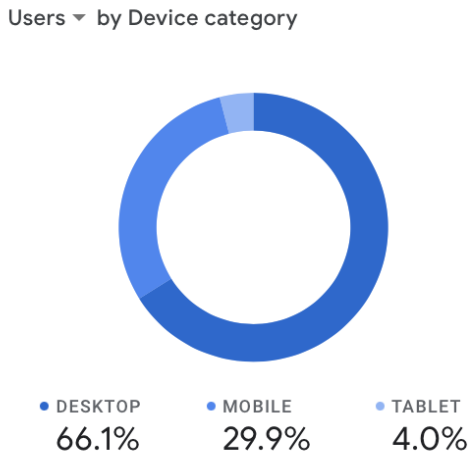
	Page title and screen class	↓ Views	Users	New users	Views per user
	Totals	9,301 100% of total	2,276 100% of total	2,275 100% of total	4.09 Avg 0%
1	MVCO – Martha's Vineyard Coastal Observatory	6,197	2,008	1,967	3.09
2	Webcam – MVCO	1,720	600	224	2.87
3	Historical Data – MVCO	247	89	7	2.78
4	Current Data – MVCO	215	139	9	1.55
5	Projects – MVCO	167	99	9	1.69
6	Data – MVCO	132	84	1	1.57
7	Infrastructure – MVCO	123	82	24	1.50
8	About – MVCO	101	66	2	1.53
9	Publications – MVCO	99	69	2	1.43
10	Vertical Wind Profile – MVCO	76	21	6	3.62

Based on the pageview results shown above, the large majority of website visits are to view current conditions, including webcam footage of South Beach and the ASIT. A smaller subset of users seek out historical data (about 2% of the views) or other information about MVCO. Note that, for this table all users are essentially 'new users'.

Somewhat unsurprisingly, much of the usage of the MVCO website comes from users on the island of Martha's Vineyard itself, potential future visitors to the island living in Boston, or residents of Falmouth (includes WHOI-based views). The local use of the MVCO's site highlights the significance of the current conditions served by MVCO to the local community.



Two thirds of users accessed the MVCO site via a desktop or laptop computer. However, a sizable percentage (~30%) of users access the website via mobile devices, highlighting the importance of the recent website redesign that included making the website mobile friendly.



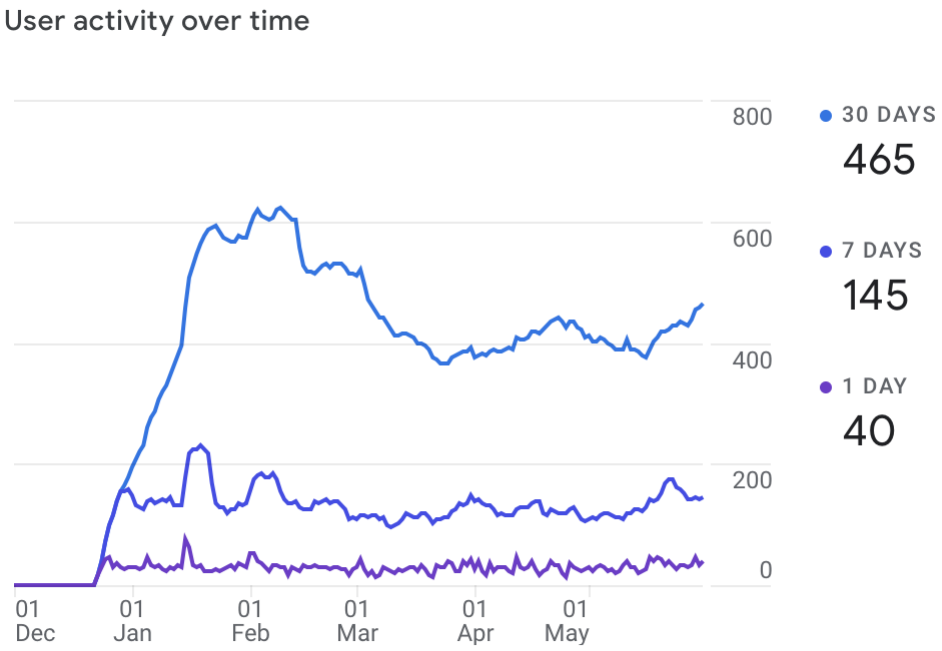
Finally, the engagement of visitors to the website can be seen by following the daily averaged use of the site, the engagement time of users on the site, and the user return rate, or the time period between subsequent views for a unique user. Again, a new user is defined as a

device/browser that had not yet visited the site prior to the observational period. A returning user has visited the site at least once before.

User engagement is typically very short, but note that 'engagement' requires some action on the part of the users, such as a scroll or a click, in addition to simply loading the page.

It appears that most users are satisfied with the information presented on the MVCO homepage, including the current conditions or webcam results. This likely use case was the main driver for the revamped website itself, to place all the information users might need on the front page to be easily accessible. With the re-designed layout of the MVCO home page, it takes minimal time view the current conditions or webcam footage.

Many of the users that visit the website will return at a later date to check the local conditions again. The average number of users with next day return rates was 40 for the full period examined, while ~450 users would return within a month to the MVCO site.



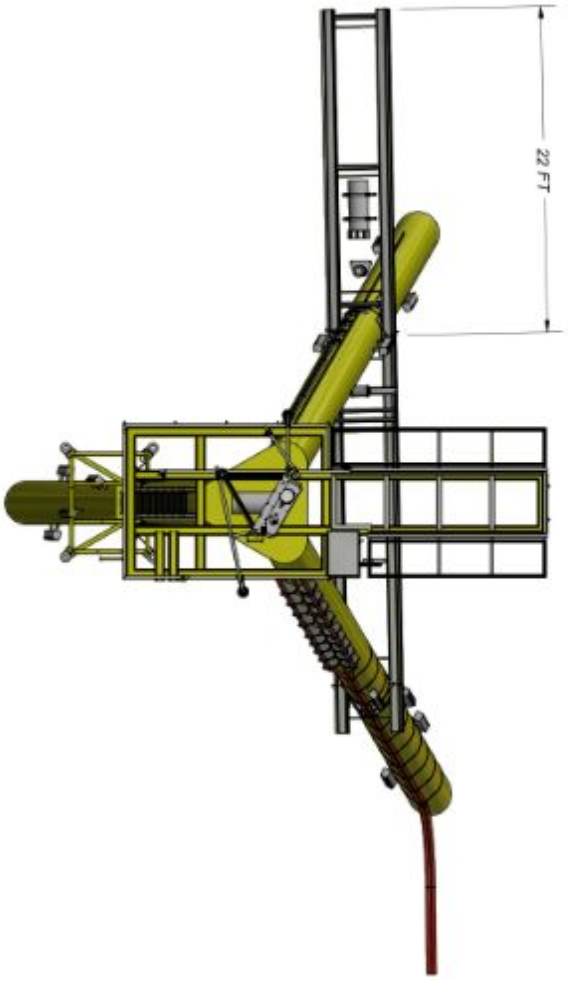
Finally, the referring website is sometimes recorded within the analytics, and suggests that most users have the MVCO pages bookmarked or within their history to be able to access it directly. A smaller number are coming to MVCO from google, Facebook, or whoi.edu searches. See the final table for the referring website on the following page.

Search... Rows per page: 10 Go to: 1

	Session source/medium	Users	Sessions	Engaged sessions	Average engagement time per session	Engag
	Totals	2,276 100% of total	6,510 100% of total	3,523 100% of total	0m 23s Avg 0%	
1	(direct) / (none)	1,828	4,339	2,020	0m 21s	
2	google / organic	284	702	443	0m 44s	
3	mvco.whoi.edu / referral	81	1,260	945	0m 21s	
4	m.facebook.com / referral	72	77	28	0m 08s	
5	whoi.edu / referral	18	23	15	0m 30s	
6	masswebcams.com / referral	16	21	19	0m 28s	
7	(not set) / (not set)	15	0	0	0m 00s	
8	bing / organic	15	22	17	0m 53s	
9	baidu / organic	11	11	0	0m 00s	
10	worldcam.eu / referral	8	9	4	0m 21s	

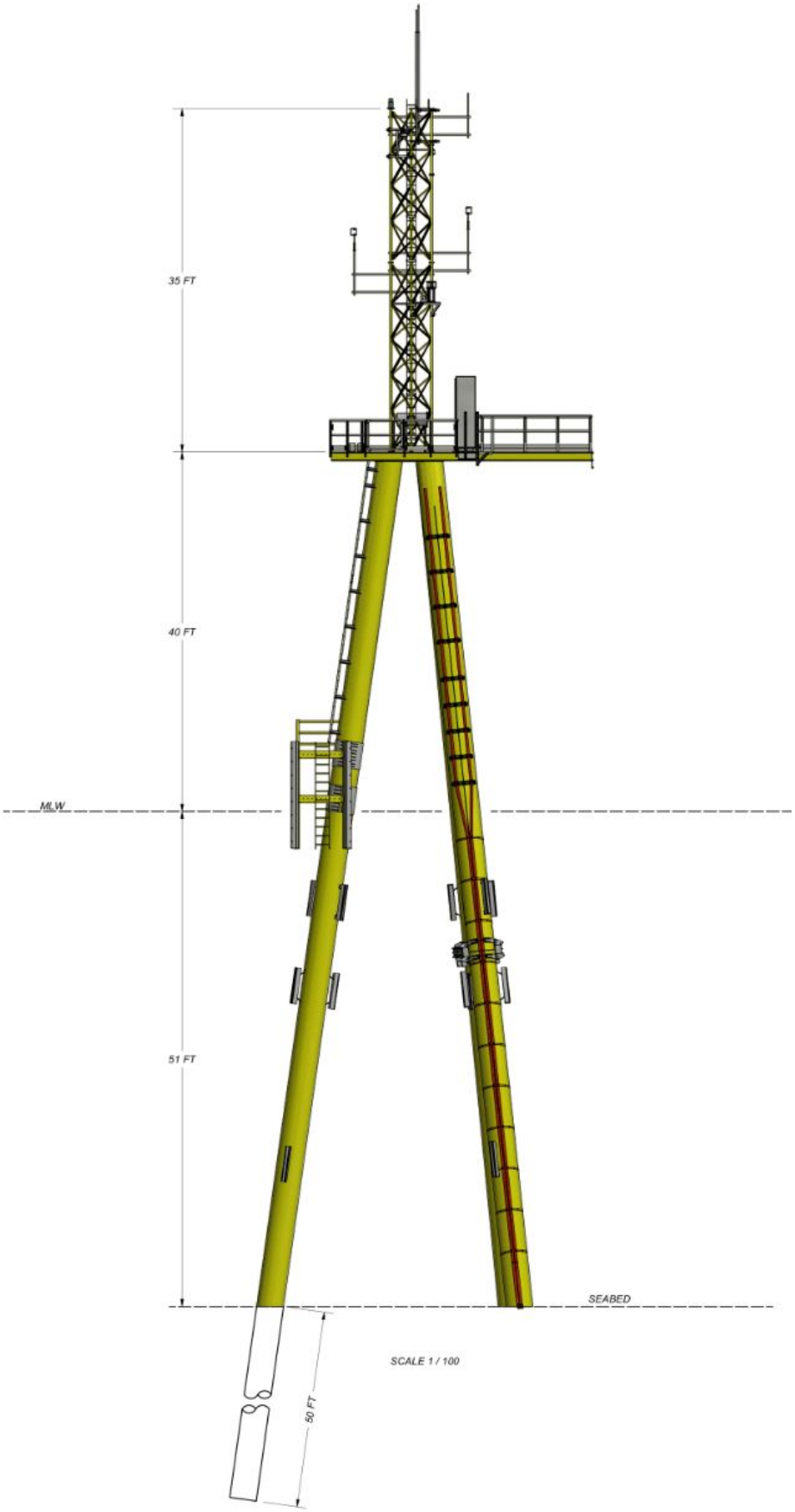
Appendix E: MVCO Infrastructure Technical Drawings Summary

ASIT schematic: from above

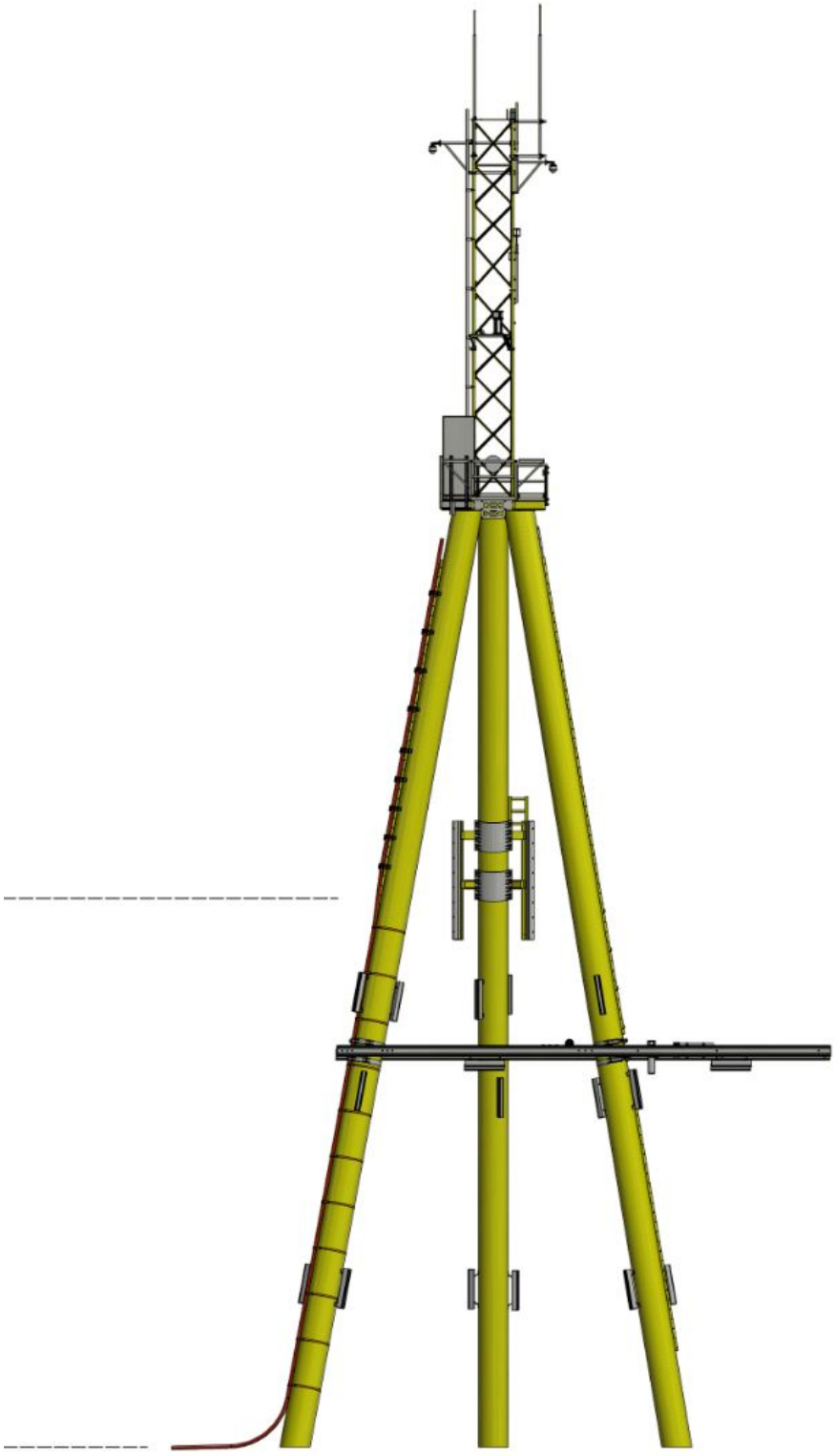


UNLESS OTHERWISE NOTED: DIMENSIONS IN INCHES TOLERANCES: DECIMAL ANGULAR .xx ± 0.01 ± 1 deg .xxx ± 0.005 BREAK ALL SHARP EDGES R0.02 MIN			WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING 86 WATER STREET, WOODS HOLE, MA, 02543
	DESIGN: J SISSON	DATE: 4/16/2020	TITLE: MVCO ASIT
	DRAFT		
MATERIAL	CHECKED		
FINISH: SEE APPLICABLE NOTES	ENGINEER		SIZE: D; DWG NO: asit_2021; REV
FILE: asit_2021.iam	WORK ORDER	PROJECT	SHEET 1 OF 1

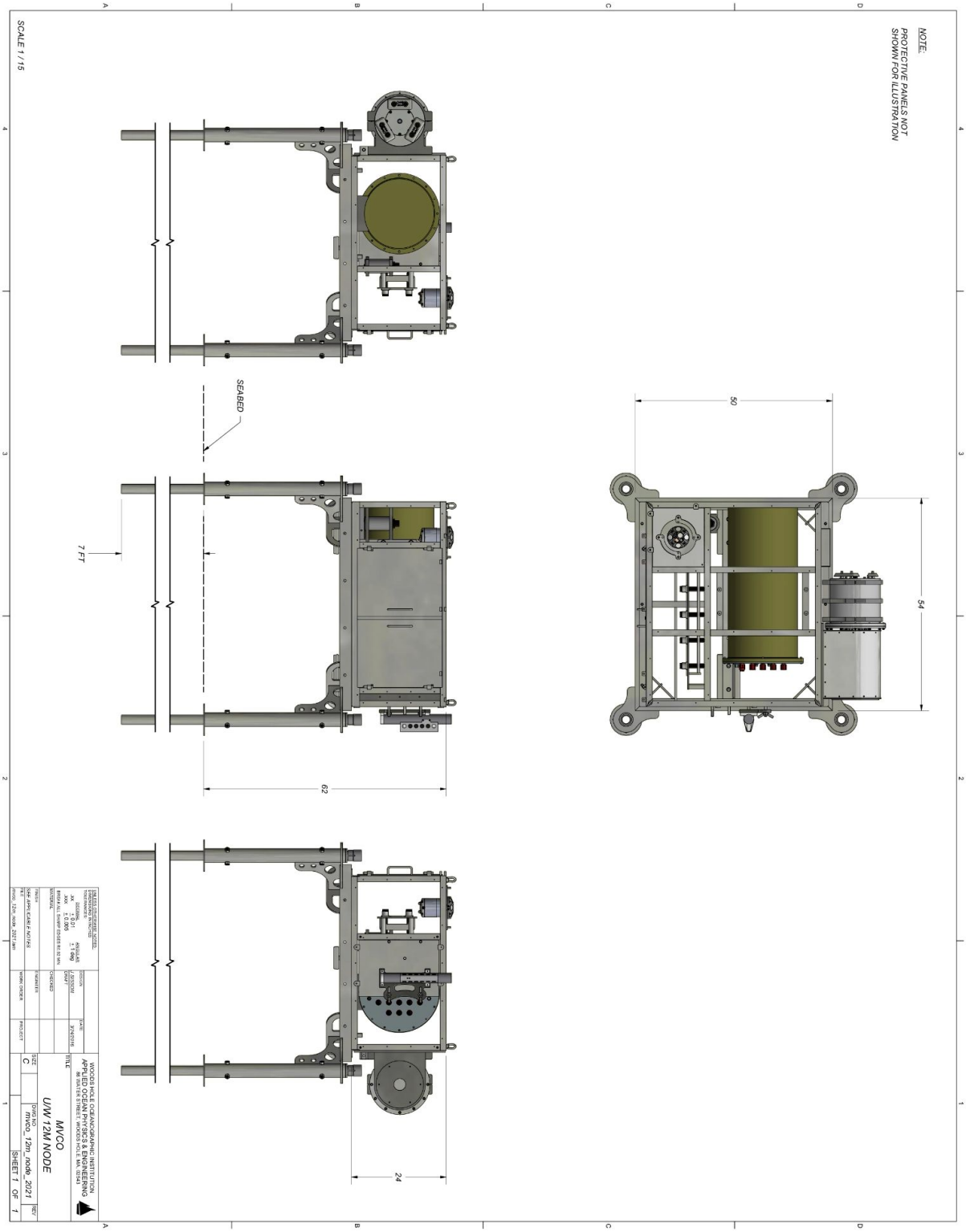
ASIT schematic: from the North



ASIT schematic: from the West



New 12-m Underwater Node schematics



MVCO cable and power connections diagram