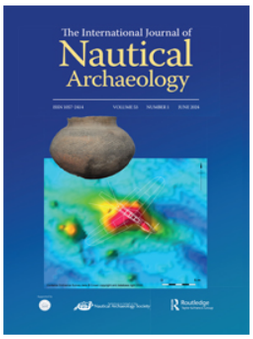

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NOTE

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Introduction

With priority placed on the exploration of deep waters, NOAA Ocean Exploration applies the latest tools and technologies to explore previously unknown areas of the ocean, making discoveries of scientific, economic, and cultural value. As both a valuable cultural resource and habitat for marine organisms, NOAA Ocean Exploration's priorities include maritime archaeology and the discovery of our underwater cultural heritage (UCH). Between 2024 and 2026, NOAA Ocean Exploration and partners will conduct exploratory seafloor mapping and remotely operated vehicle (ROV) explorations in the Pacific Basin. This article details the tools, technologies, and typical datasets collected by our program and opportunities for the Asia-Pacific community of archaeologists, historians, and resource managers to contribute to our UCH research prioritization and participate in our live, publicly accessible telepresence-enabled operations. Using this community-driven archaeology model, we ensure this exploratory work will have the greatest impact and provide a publicly accessible platform for sharing our common cultural heritage. NOAA Ocean Exploration is dedicated to exploring the unknown ocean, unlocking its potential through scientific discovery, technological advancements, and data delivery. By working closely with partners across the public, private, and academic sectors, we are filling gaps in our basic understanding of the marine environment. This allows us, collectively, to protect ocean health, sustainably manage our marine resources, accelerate our national economy, better understand our changing environment, and enhance our appreciation of the importance of the ocean in our everyday lives.

Since the program's inception in 2001, NOAA Ocean Exploration has been a substantial source of U.S. public funding for the prioritization, discovery, and protection of UCH that opens windows into the past to improve understanding of the history of human interaction with the ocean. These activities are executed through a host of mechanisms, including NOAA Ocean Exploration-led operations as well as partner operations supported through a competitive grant program, the National Oceanographic Partnership Program, and the NOAA Ocean Exploration Cooperative Institute, which includes Ocean Exploration Trust and its Exploration Vessel *Nautilus*, a partner vessel in exploration. Discoveries and technological advancements made through these mechanisms improve and enhance our understanding of the oceans.

Through its support to and involvement of partners, NOAA Ocean Exploration makes it possible for them to discover and explore significant UCH sites including World War II (WWII) maritime cultural landscapes (NOAA Ocean Exploration, 2023c), outer continental shelf palaeolandscapes (NOAA Ocean Exploration, 2022b), historic shipwrecks (NOAA Ocean Exploration, 2019); improve UCH survey techniques including utilization of synthetic aperture sonar (White, 2019), laser line scanners (Albiez, et al., 2019), autonomous underwater vehicles (NOAA Ocean Exploration, 2022a), photogrammetry for archaeological documentation (BOEM, 2023), and enhance community engagement, data sharing, and relationships with Indigenous communities (Blaney, 2016; NOAA Ocean Exploration, 2011) (Figure 1).

Input from the archaeological community is pivotal to the success of NOAA Ocean Exploration-led UCH operations, in particular. This input includes suggestions for UCH areas to explore as well as guidance on best practices for archaeological documentation and data collection. Over the years, NOAA Ocean Exploration has successfully incorporated input from

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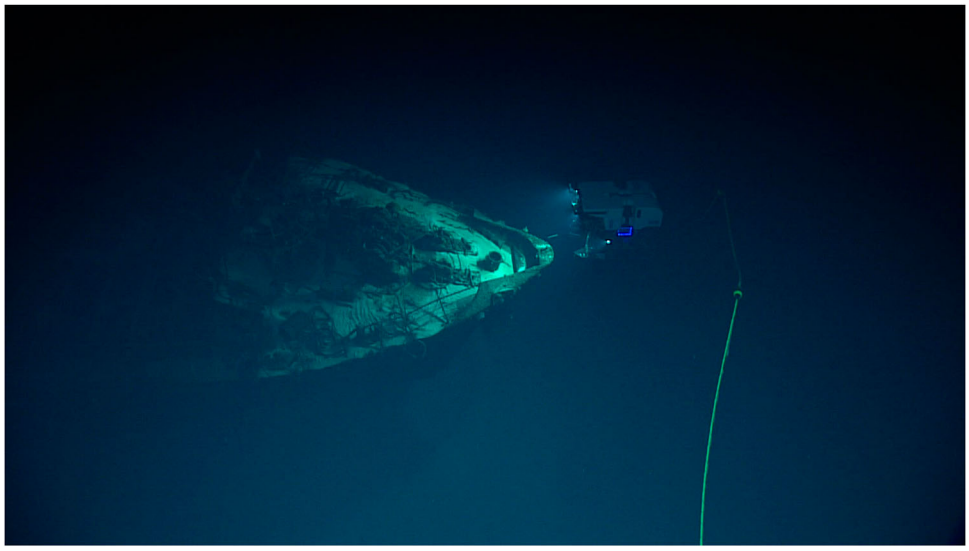

Figure 1. Remotely operated vehicle *Deep Discoverer* at the bow of *Amakasu Maru No. 1*. Source: NOAA Ocean Exploration.

academic, public, private, local, and Indigenous partners in their exploration of UCH resources as well as the improvement of the technologies used for UCH surveys.

This paper focuses on NOAA Ocean Exploration-led operations. It describes how members of the Asia-Pacific archaeology community can engage with upcoming operations and contribute to a prioritization matrix for site selection in the region.

NOAA Ocean Exploration Operations

NOAA Ocean Exploration follows a nested approach to expedition planning that entails packaging individual weeks-long expeditions into a series of expeditions – and sometimes multiyear campaigns – forecasting operations three to five years out. This lead time ensures staff have enough time to plan expeditions and consider ocean science community priorities in the development of mission objectives and identification of areas of operation.

Presently, NOAA Ocean Exploration is scoping priorities for a Pacific Basin campaign between 2024 and 2026. Though subject to change as mission planning evolves, areas of operation under discussion include: Line Islands, Pacific Remote Islands Marine National Monument (Johnston Atoll, Wake Atoll, Howland Island, Baker Island), Marshall Islands, Papahānaumokuākea Marine National Monument, Commonwealth of the Northern Mariana Islands, Cook Islands, Palau, and Guam.

As part of this upcoming campaign, NOAA Ocean Exploration will conduct operations in the Pacific Basin including aboard NOAA Ship *Okeanos Explorer* (NOAA Ocean Exploration, 2023a) using four types of sonars to collect high-resolution seafloor and water column data (Table 1), a dual-body remotely operated vehicle (ROV) system capable of diving to depths up to 6,000 m, and a suite of other instruments to help characterize the ocean, including a dynamic positioning system. Unlike many other ocean expeditions supported by NOAA, most of the scientists participating in NOAA Ocean Exploration's expeditions do so from shore, thanks to telepresence technology (NOAA Ocean Exploration, 2023d).

NOAA Ocean Exploration uses a high-bandwidth satellite communications system capable of transmitting mapping and oceanographic data and real-time, high-definition video feeds from the ROVs through network connections to scientists on shore. Thus, a theoretically unlimited number of scientists can add their expertise to expeditions. At the same time, members of the public can also join in the excitement of ocean exploration and discoveries from their classroom, newsrooms, or home (Figure 2).

Sensitive Data Protection

Many of the UCH sites explored by NOAA Ocean Exploration require sensitive data stewardship and

Table 1. Data, and the respective file formats, typically collected during seafloor and water column mapping and remotely operated vehicle operations (adapted from Cuellar, 2023).

File Type	File Format
Multibeam Echosounder (EM304)	.kmall, .raw, .idx, .bot, .asc, .sd, .xyz
Split-Beam Echosounder (EK60/80)	.raw, .idx, .bot
Acoustic Doppler Current Profiler (ADCP; Teledyne Workhorse Mariner 300kHz and Teledyne RDI Ocean Surveyor 38kHz)	.raw
Sub-Bottom Profiler (Knudsen Chirp 3260)	.xtf, .keb, .txt, .segy
Conductivity, Temperature, and Depth (CTD; SeaBird SBE9-11 Plus and SBE32 Carousel With 12 10-liter Niskin Bottles)	.asvp, .hrd, .hex, .xmlcon
ROV High-Definition Video	.mov
ROV High-Definition Still Images	.tiff, .jpeg, .jpg
Geospatial Data	.kmz, .shp, .tif, .kml, .txt
Expendable Bathythermograph (XBT)	.xbt
Event Logs and Dive Summaries	.txt, .pdf

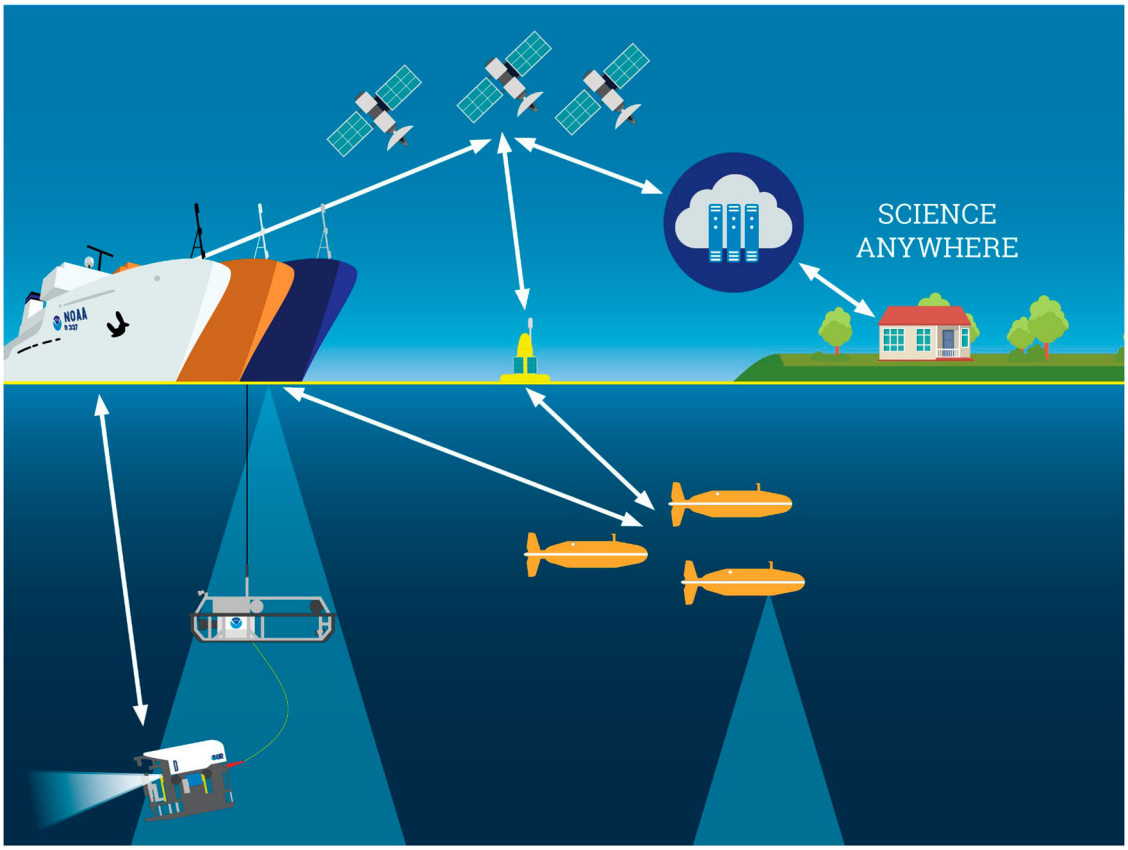

Figure 2. Telepresence-enabled exploration. Source: NOAA Ocean Exploration.

protection measures. The United States has several laws and regulations in place to protect UCH sites and safeguard sensitive information and data from improper release. To meet federal preservation mandates applicable to sensitive data management, including the National Historic Preservation Act (NHPA, 2021) and the Sunken Military Craft Act (SMCA, 2021), NOAA Ocean Exploration follows strict internal planning, acquisition, post-processing, and archiving protocols for all seafloor mapping, ROV, and location-bearing data collected on UCH sites. In addition, NOAA Ocean Exploration determines the eligibility for listing on the National Register of Historic Places of every UCH site where data are collected. Should a site be determined eligible for listing, NOAA Ocean Exploration initiates a National Historic Preservation Act Section 304 consultation with the Keeper's Office of the National Register of Historic Places and relevant UCH site partners with research, management, or jurisdictional interest, including partners who suggested exploration of the site. Section 304 of the National Historic Preservation Act requires federal agencies to withhold from public disclosure information about the location, character, or ownership of a historic property if disclosure of such information may cause a significant invasion of privacy, risk harm to the historic property, or impede the use of a traditional religious site by practitioners. Section 304 is only applicable to UCH sites eligible for, or listed on, the National Register of Historic Places. If the site is a sunken U.S. military craft, NOAA Ocean Exploration and NOAA General Counsel work with Defense Secretaries to protect sensitive data under the SMCA.

Community-Driven Archaeology

NOAA Ocean Exploration has adopted a unique model of community-driven exploration that serves broad community interests and addresses data gaps while being responsive to specific community, agency, administration, and global priorities and drivers. This 'Explorer Model' brings together the ocean science and resource management communities to collaboratively plan expeditions and explore areas of the deep ocean where data are scarce (Cantwell et al., 2020b) (Figure 3). NOAA Ocean Exploration is employing the Explorer Model in the 2024–2026 campaign in the Pacific Basin.

The Explorer Model also applies to UCH exploration planning. Input regarding archaeological priorities from all interested parties, including state, local, and tribal governments and Indigenous communities, is fundamental to ensuring that NOAA Ocean Exploration activities in the Pacific address priorities of, and are driven by, the archaeology community and help meet the heritage management and research

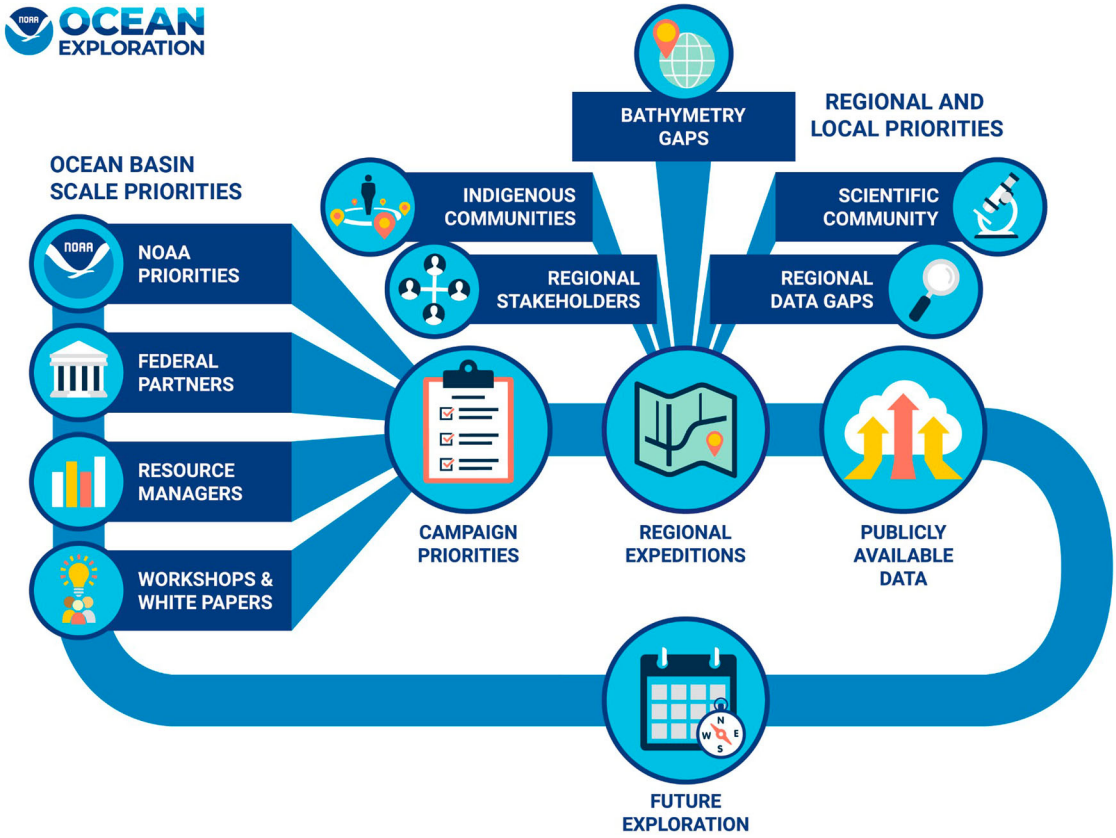

Figure 3. Foundations of the Explorer Model (adapted from Cantwell et. al., 2020a).

needs of partners. It is this goal, of community-driven archaeology, that the program strives to achieve to maximize return and engagement on UCH exploration efforts.

Archaeologists, historians, resource managers, and others who engage in and research UCH from all sectors are invited to submit UCH priorities directly to NOAA Ocean Exploration. These submissions usually contain sensitive information that may include geographic coordinates of known or potential archaeology material, literature reviews of after-action reports, eyewitness accounts, and other primary source material. Dataset sensitivity is prioritized by NOAA Ocean Exploration and exchanges of sensitive information are brokered through a non-disclosure agreement, with data access limited to NOAA Ocean Exploration and submitting partner(s). By signing this agreement, all parties agree not to share these sensitive data without explicit permission from the partner(s). Once data sharing agreements are in place, NOAA Ocean Exploration creates an internal document containing contextual maps, site summaries, and links to relevant remote sensing data to inform operations planning.

UCH recommendations are then added to an ArcGIS Pro 3.1.0 database and prioritized by historical and traditional significance, amount of community interest, environmental factors (estimated depth, existing data, substrate, confidence in existing coordinates), and potential hazards that affect probability of mission success. Expedition planners then correlate the recommendations with the planned operating areas of the ship and decide which UCH sites to consider for exploration. This process is exemplified by the following two case studies that showcase the Explorer Model and the importance of partner contributions to marine archaeology investigations.

B-29 Case Study

The Explorer Model is best exemplified by the 2016 discovery and characterization of a B-29 Superfortress aircraft lost in the Saipan Channel (Cantwell et. al., 2020a). This site and the potentially ten other aircraft lost in this area include 53 service personnel missing in action. As such, the Defense POW/MIA Accounting Agency (DPAA), which is responsible for the repatriation of unaccounted for Americans, became intrinsically involved and was able to support the mission by providing subject-matter expertise and information on open aircraft case files for the area. Additional historical and archaeological data were provided by the B-29 Restoration Team, the Seattle Museum of Flight, aviation historians, Texas Agricultural and Mechanical (A&M) University's Nautical Archaeology Program, the Smithsonian National Air and Space Museum, East Carolina University's Maritime Studies Program, the United States Air Force, the Scripps

Institution of Oceanography, the Cavanaugh Flight Museum, the Commonwealth of the Northern Mariana Islands Division of Historic Preservation, and NOAA's Office of National Marine Sanctuaries (Lickliter-Mundon et. al., 2018).

The discovery of this resource furthered public appreciation for, and academic understanding of, the B-29s lost near the Tinian North Field and served as a case study for deepwater ROV characterization of aircraft wreckage. The investigation also resulted in a successful National Historic Preservation Act Section 304 consultation with the Keeper of the National Register of Historic Places. The Keeper concurred with NOAA Ocean Exploration's determination that the B-29 was eligible for listing on the National Register of Historic Places under Criterion A: Military through its participation in Pacific theatre WWII combat operations off Tinian Island and C: Design/Construction as a rare submerged example of a significant design advancement in aviation history (NPS, 1990). Public release of B-29 location data was determined to introduce risk of harm by increasing the likelihood of looting or other disturbance.

Partner collaboration on the B-29 was pivotal at every step, from submitting it as a priority target to site discovery, characterization, peer-reviewed publication of research, and sensitive data protection and stewardship. Only with the collaborative and collective research of the partners listed above was the eligibility determination possible.

Amakasu Maru No.1 Case Study

The WWII Battle of Wake Island claimed an estimated 900 to 1,000 Japanese soldiers and 100 American soldiers during the 16-day siege. The bravery and memory of these Japanese soldiers are entombed in 21 aircraft, one submarine, and two destroyers lost during their attempted taking of Wake Island. The Americans also lost several aircraft during the island's defense. On 11 August 2016, NOAA Ocean Exploration and partners from the Hawaii Undersea Research Laboratory, University of Hawaii, the Global Foundation for Ocean Exploration, and multibeam echosounder expert Gary Fabian investigated an anomaly thought to be the potential remains of the Imperial Japanese Navy Kamikaze-class destroyer *Hayate*. ROVs *Deep Discoverer* and *Seirios* provided the first glimpse of the hull, whose side markings, armament, and cabin structure revealed it was not *Hayate*, but the Japanese water tanker *Amakasu Maru No. 1* (Figure 1).

Amakasu Maru No.1 was sunk by the USS *Triton* on 24 December 1942, after sustaining heavy torpedo damage on the port side off Wake Atoll, now located in the Pacific Remote Islands Marine National Monument. The ship now sits upright and serves as a habitat for anemones, glass sponges, anglerfish, squat lobsters, and other animals. Its remains were fully documented by the exploration team, and the entire ROV dive was broadcast live to engage participating scientists ashore and to share this important UCH site with the public (Cantelas and Wagner, 2016).

Data from this dive became the subject matter for a master's thesis that further characterized the site and its place in history (Yoxsimer, 2022). Yoxsimer's thesis exemplifies student-led products supported by NOAA Ocean Exploration-collected data and potential student engagement opportunities for upcoming missions in the Pacific Basin. From beginning to end, UCH partnerships allowed NOAA Ocean Exploration to discover *Amakasu Maru No. 1* and memorialize the sacrifices made by the sailors aboard. Now, *Amakasu Maru No. 1* is known in the archaeological record and its story can be shared with the world.

Conclusion

Between 2024 and 2026, NOAA Ocean Exploration will continue its community-driven exploration in the Pacific Basin. This presents an opportunity for the Asia-Pacific UCH community to participate in the planning, execution, and post-expedition data workup. While there are no guarantees on the amount, location, and frequency of UCH operations, NOAA Ocean Exploration is looking to the Asia-Pacific UCH community to help guide the Pacific campaign. This will lean heavily on partnerships, both familiar and new, including international collaborative efforts. Together, we can prioritize, explore, discover, and protect the important deep water UCH resources of the Pacific Basin and broaden understanding of our collective past.

Information about how to participate in the Pacific Basin campaign is available on the NOAA Ship *Okeanos Explorer*: Get Involved web page (NOAA Ocean Exploration, 2023b) and through the authors of this paper, who can facilitate participation.

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Author Contributions

Phil Hartmeyer served as corresponding and primary author; all co-authors contributed to the writing and editing of the manuscript. Its content has been informed by Pacific investigations and community-driven archaeological missions led and supported by co-authors and NOAA Ocean Exploration.

Disclosure Statement

The authors declare no conflict of interest.

Permissions

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