

Patrick S. Cross, Ph.D.

PRESENT POSITION

Senior Project Specialist, Hawaii Natural Energy Institute, University of Hawaii at Manoa

EDUCATION

Ph.D., Meteorology, Naval Postgraduate School, 2003

M.S., Physical Oceanography, Naval Postgraduate School, 1993

M.S., Meteorology, Naval Postgraduate School, 1993

B.S., Geophysics, New Mexico Institute of Mining and Technology, 1982

EXPERIENCE

July 2013 to present

Senior Project Specialist, HNEI, University of Hawaii at Manoa

Managed proposal efforts, and now serving as Project Manager and Principal Investigator for three substantial (\$9M, \$3.75M, and \$5.8M) infusions of funds to provide research and logistics support to the U.S. Navy's Wave Energy Test Site (WETS), off Marine Corps Base Hawaii (MCBH). All three projects are funded by NAVFAC through the Applied Research Laboratory at UH, and represent a major portion of that new organization's current funding. Oversee collection of acoustic and other environmental data in the vicinity of wave energy devices under test (4 device deployments to date), analysis of survivability and electrical generation data from the devices, and manage all logistical support to the Navy and to wave energy developers who test at WETS. Conceived, promoted, and oversaw two follow-on WEC deployments at WETS – one to redeploy the Northwest Energy Innovations Azura device, featuring modifications to the device intended to improve performance, and one a redeployment of the Fred. Olsen Lifesaver device at the WETS 30m test berth. The latter project featured improvements to the mooring design aimed at improved performance and the inclusion, through a partnership with University of Washington, of a suite of environmental sensors, including active and passive sonars, optical and acoustic cameras, and a subsea charging capability. This system is powered exclusively by electricity generated by the WEC, making this a project of high interest to both Navy and DOE. Also oversaw ONR-funded projects in support of WETS, including the acquisition and testing of an ROV through subcontract with our marine services partner company. Act as the Navy's primary onsite representative at WETS, and conduct extensive outreach and media efforts related to wave energy. Have quickly become a sought-after speaker at various marine energy conferences and workshops. Also oversee projects involving photovoltaic test beds in Hawaii, and analysis of the data from those test beds, leading toward publication of some novel methods and results.

May 2006 to March 2013

Senior Scientist, OASIS, Inc.

Principal Investigator, involved in a wide variety of projects, including an ONR initiative to transfer ocean glider technology to the Naval Oceanographic Office (including adaptive sampling and data visualization techniques), fielding multiple gliders during exercise Rim of the Pacific 2006, Center of Excellence for Research in Ocean Sciences (CEROS) and ONR marine mammal monitoring projects using gliders integrated with acoustic arrays and autonomous onboard processing, and a leadership role in a multidisciplinary ONR field collaboration with scientists in the US and Taiwan, examining the effects of a wide range of factors (geoacoustics, oceanography, meteorology, shipping, bathymetry, etc.) on acoustic propagation uncertainty in an East China Sea shelf area. Coordinated many aspects of oceanographic and acoustic tests for this program, involving many at-sea periods and multiple ships.

Most recent projects included a CEROS collaboration with UH scientists, involving improved assimilation of glider data into ocean models (through the coupling of ocean models

with a glider kinematic model), marine mammal monitoring during Navy exercises (examining effects of mid-frequency active sonar on humpback whale vocalizations during Submarine Commanders Course events in Hawaiian waters, in particular), and providing coordination between ONR's Persistent Littoral Undersea Surveillance (PLUS) program and fleet commands, as that program moves toward transition to the fleet. PLUS involves autonomous vehicles (Seagliders and powered REMUS AUVs) conducting ASW, which involves a range of challenges, including acoustic communication between vehicles, onboard signal processing (including detection, beamforming, track generation, and message transmission), deployment, recovery, and coordination of multiple autonomous platforms, waterspace management when working with submarines, mission planning based on acoustic propagation conditions, ocean currents, and vehicle capabilities, and comprehensive ASW-relevant data fusion. Acted as submarine rider, test plan author, glider pilot and command/control coordinator for recent PLUS demos in the US and overseas.

Served as Project Manager for an ONR program called Ocean Sentinel, in which a wind-driven surface vessel (a converted 50 foot ocean-going trimaran outfitted with a 60 foot rigid wing) was being outfitted as a long-endurance multi-sensor platform capable of hosting a wide range of sensors and communications. This platform was envisioned, ultimately, as an autonomous, unmanned craft capable of months at sea (through various forms of energy scavenging), while hosting a wide variety of mission-driven sensors and transmitting real-time data and imagery back to a command center.

Maintained an office at Pearl Harbor to provide liaison between ONR and the submarine force, the Pacific Fleet, and other Navy commands, as well as the University of Hawaii. Involved in writing many successful funding proposals and detailed project reports, traveling to sea tests and collaboration and program meetings in DC and around the country (and world), presenting many technical and program briefs, and representing OASIS and ONR during Hawaii fleet-oriented business development efforts. Also have served extensively as an ONR facilitator of sea tests in Hawaiian waters.

March 2002 to April 2006 Force Oceanographer, Submarine Force, U.S. Pacific Fleet
Managed all aspects of oceanographic, weather, and charting support to the submarine fleet in the Pacific and Indian Oceans, ensuring that support products were delivered in a timely and relevant fashion within the unique communications and operational constraints inherent in submarine operations. Provided in-port and at-sea tactical oceanography training to submarines in preparation for deployments.

Placed a strong emphasis on fostering a closer relationship between the R&D community and operational fleet requirements. Initiatives included the use of ocean gliders in support of characterizing the ocean for submarine operational decision support, development of ocean modeling techniques in conjunction with ONR and research interests, atmospheric propagation predictions for submarine mast detection vulnerability assessment, ocean optics/bioluminescence, and the effects of ocean internal waves on submarine depth control and acoustic propagation. Served as fleet representative to an ONR research effort aimed at quantifying uncertainty factors in acoustic propagation in various tactically relevant parts of the world. From concept to execution, led the effort to host a workshop in Hawaii that featured briefings by ONR-funded basic researchers to senior and junior fleet representatives on oceanographic and acoustic topics of strategic and tactical relevance. The scientists were infused with a sense of the relevance of their work, and the operators were thrilled to have the opportunity to effect the direction of ongoing research. Led a project to conduct a first-ever launch of a Slocum glider from an SSN dry deck shelter in 2005.

Assumed a leadership role in submarine bathymetric chart issues in the wake of the USS San Francisco grounding, with emphasis on re-prioritizing Navy oceanographic survey requirements, making use of satellite altimeter-derived depths in poorly charted areas, use of

gravity vertical deflection data for improved inertial navigation, providing guidance to chart developers at the Naval Oceanographic Office and National Geospatial-Intelligence Agency, and providing detailed training to submarine navigation teams.

January 2000 to February 2002 Meteorologist/Oceanographer, USS NIMITZ Battle Group
Provided the full range of meteorology and oceanography support to battle group assets during all exercises and operations, including a South American deployment that involved avoidance of tropical systems, a challenging transit of the Drake Passage, and flight operations in fog-prone areas off the coast of Peru. Additional roles included battle group Training and Readiness, which involved the oversight of deployment preparations for all battle group assets (redesigned the previously-used training/readiness tracking system to more efficiently identify issues before they became critical), as well as serving as ASW and Mine Warfare Officer. Oversaw crew re-certification of USS NIMITZ after a 3-year overhaul period. Attended extensive training in Corpus Christi, Texas on US Navy mine warfare planning. Stood regular at-sea watches as the Battle Group Admiral's direct representative for all tactical, strategic, and safety issues, including monitoring the actions of the battle group in real time and maintaining alert posture for any perceived threats. At-sea operations onboard USS NIMITZ occurred in the immediate wake of the 9/11 terrorist attacks, creating an unusually tense atmosphere.

January 1994 to September 1996 Officer-in-Charge, Meteorology/Oceanography Detachment
Supervised 12 civilian and military personnel providing flight weather briefing support to all aircraft operating from Naval Air Station Fallon, NV. Primary customers were carrier-based aircraft involved in strike warfare training prior to deployment to the Persian Gulf. Also served as tactical weather expert for the Naval Strike and Air Warfare Center, which deals with all aspects of strike warfare readiness, including the TOPGUN school. Special project to assess and improve electro-optical decision aids and target recognition in various atmospheric and thermal conditions. Also oversaw a major renovation of office spaces and upgrade of information technology systems. In addition to a solid record of aviation forecasting, the most important achievement was the conversion of the weather office from a situation plagued with personnel issues to a professional and successful enterprise with steady personnel advancement. It became the model for other similar offices in the US Navy.

May 1989 to July 1991 Oceanographer/ASW Specialist, ASW Operations Center Bermuda
Provided oceanographic support to ASW aircraft operating from Bermuda, including prediction of acoustic detection ranges for optimal placement of sonobuoys based on ocean conditions. Served as ASW flight briefer, covering all aspects of tactics, communications, and flight safety for supported US and NATO P-3/S-3/CP-140/Nimrod aircraft. Served as Watch Captain and held several leadership roles, including running the materiel division and serving as the Senior Watch Officer for Naval Air Station Bermuda.

January 1987 to March 1989 Sonar/Communications Officer, USS FLORIDA
Fully qualified in all aspects of submarine operations, including strategic mission, with emphasis on sonar systems, tactics and communications. Qualified as In-Port Duty Officer and underway Officer of the Deck, earning a submarine warfare specialty. As Communicator and Security Manager, oversaw the maintenance and security of the extremely sensitive nuclear weapons authentication system, as well as maintaining custody of all classified material. Increased awareness, on the part of the sonar division and the officers, of oceanographic variability as it impacted routine submarine operations. This was done through a regular plot of fronts/eddies, not previously done, and regular training on tactical oceanography. Completed four strategic deterrent patrols in the north Pacific Ocean.

June 1981 to May 1985 Exploration Geophysicist, Getty Oil Company/Texaco, Inc.
Position involved the field acquisition and in-office interpretation of seismic data for the purpose of oil and gas exploration in Oklahoma and Texas. Worked closely with geologists and land rights specialists to develop prospective drilling locations. Developed several viable prospects at Getty Oil before company was purchased by Texaco in late 1983. Managed transition of data, techniques and drilling prospects to the new company at offices in Denver.

PROFESSIONAL AFFILIATIONS

Marine Technology Society, member, Secretary of Hawaii Chapter effective June, 2015
American Geophysical Union, past member
American Meteorological Society, past member
International WaTERS (Wave and Tidal Energy Research Sites), member
Pacific Marine Energy Center – South Energy Test Site (PMEC-SETS) Technical Advisory Group, member

PROPOSALS SUBMITTED AND/OR AWARDED

July 2018 Extended Research Support to the U.S. Navy Wave Energy Test Site – \$5.8M awarded by NAVSEA through the UH Applied Research Laboratory. Continues and expands tasking in support of WETS. Research support to WETS (ongoing inspections, power performance assessments, environmental monitoring) through FY2022, including expanded acoustic collections and a second phase of development of Makai’s micropiler technology. Also sets funds aside for additional mooring repair work and other infrastructure maintenance. Three-year project involving about 25% of my time initially, growing to about 50% in latter three years. Primary author and proposal lead.

May 2018 Concept paper submitted as PI to DOE FOA 1837 relating to advancement of a wave energy concept conceived by Dr. Richard Carter – a recent UH ORE PhD graduate. The Wave Focusing Energy Converter concept was encouraged for submission of a full proposal, which was submitted in July. Awaiting final selection. Proposal was for \$1.29M federal, with \$357K cost share. Project would cover about 1/10th of my time over three years.

Feb 2018 Concept paper submitted as PI to ARPA-E FOA relating to advancement of a wave energy converter concept. Not encouraged for full proposal submission.

Feb 2017 High Value Fuel and Chemicals from Wave Energy Platforms – DOE SBIR led by Proton OnSite, investigating the generation of hydrogen from wave power at Marine Corps Base Hawaii. HNEI funding \$50K. Not selected for Phase 1 funding.

Sep 2016 Additional Tasking for ARL/HNEI Wave Energy Test Site (WETS) Research - \$3.75M awarded by NAVSEA through the Applied Research Laboratory. Two-year project involving approximately 30% of my time. Primary author and proposal lead. Awarded September 2016.

Oct 2015 Provided inputs to a Norwegian proposal requesting funds to expand efforts at a wave energy test facility at Runde, Norway. Limited funding, to cover a small amount of time for phone conferences and emails, plus a trip to Norway in late 2016. Not funded.

Sep 2015 Asia Pacific Research Initiative for Sustainable Energy Systems 2015 – Office of Naval Research. Provided new task for ocean energy portion of SOW. Included 5 months of my time total, over a 4-year period. Funds requested \$313K (portion of larger HNEI-wide proposal).

Mar 2015 A Composite Solid-Inflatable Structure for Use With a Helmholtz Oscillating Water Column (HOWC), submitted in response to Department of Energy FOA 1182 for innovative structures relating to marine energy. Organized team – UH (HNEI and ME), University of Victoria (West Coast Wave Initiative), University of California Berkeley, and Ocean Energy USA, LLC. Led proposal effort, acted as primary author. Project was to build scaled prototypes of

- wave energy converters for tank testing at Berkeley and Carderock, incorporating extensive numerical modeling and innovative composite materials/methods from ME. Federal funds requested \$1.5M, including 1/6 of my time for 2 years. Proposal was not selected.
- Sep 2014 Asia Pacific Research Initiative for Sustainable Energy Systems 2014 – Office of Naval Research. Provided inputs to wave energy portion of SOW, including budget.
- May 2014 California-Hawaii MHK University Consortium – Department of Energy. Collaborative proposal submitted, with California Polytechnic Institute as lead university, to conduct various marine hydrokinetic research. Requested amount was \$5M, in response to DOE FOA. Not selected.
- Nov 2013 Support to the Navy’s Hawaii Wave Energy Test Site - \$9M awarded by NAVSEA through the Applied Research Laboratory. Awarded July 2014. Four-year project involving 50% of my time for two years and 75% for subsequent two years.
- Sep 2013 Asia Pacific Research Initiative for Sustainable Energy Systems 2013 – Office of Naval Research. Provided inputs to wave energy, seawater air conditioning, and OTEC task definitions, including SOW and budgets. Assisted with editing of entire statement of work document.

PUBLICATIONS

- Li, N., K. F. Cheung, J. E. Stopa, F. Hisao, Y. L. Chen, L. Vega, P. Cross, Thirty-four Years of Hawaii Wave Hindcast from Downscaling of Climate Forecast System Reanalysis, *Ocean Modeling*, April, 2016, 100, pp. 78-95.
- Van Uffelen, L. J., E. M. Nosal, B. M. Howe, G. S. Carter, P. F. Worcester, M. A. Dzieciuch, K. D. Heaney, R. L. Campbell, and P. S. Cross, Estimating uncertainty in subsurface glider position using transmissions from fixed acoustic tomography sources, *J. Acoust. Soc. Am.*, October 2013, 134(4), pp. 3260-71.

Non-peer reviewed publications and other research activities

- P. Cross, Wave Energy Test Site updates. Invited presentations, overview and environmental research summary at the International Wave and Tidal Energy Research Sites (WaTERS) workshop, National Taiwan Ocean University, Keelung, Taiwan, September 2018.
- P. Cross, Test infrastructure suitability for development of maritime market applications of marine energy. Invited participation in panel at the Ocean Renewable Energy Conference (OREC), Portland, OR, September 2018.
- P. Cross, WETS in-water developments, lessons learned, and supply chain issues. Invited participation in panel at Hydrovision 2018, Charlotte, NC, June 2018.
- P. Cross, WETS in-water developments/update. Invited panel participation at International Marine Renewable Energy Conference, Washington, DC, May 2018.
- P. Cross, Navy Wave Energy Test Site Overview. Invited presentation at Oregon Wave Energy Trust’s Ocean Renewable Energy Conference, in a panel on DOD involvement in marine energy development, Portland, OR, September 2017.
- P. Cross, L. Vega, K. Rajagopalan, G. Nihous, N. Li, A. Rocheleau, P. Anderson, U.S. Navy Wave Energy Test Site – Early Findings. Reviewed paper submission to European Wave and Tidal Energy Conference, Cork, Ireland, August 2017, 9 pages, included in conference proceedings.
- P. Cross, Navy Wave Energy Test Site Overview. Invited presentation at Oregon Wave Energy Trust’s Ocean Renewable Energy Conference, in a panel on marine energy test infrastructure, Portland, OR, September 2016.
- A. Devisser, P. Cross, L. Vega, B. Polagye, Navy Wave Energy Test Site Environmental Monitoring. Stood in for invited NAVFAC WETS Project Manager to deliver a lunch seminar at OREC, Portland, September 2016.

- P. Cross, Overview of WETS Research Activities. Invited presentation at Virginia Tech's 11th Annual Energy Harvesting Workshop, Arlington, VA, September 2016.
- P. Cross, U.S. Navy Wave Energy Test Site – Research Update. Accepted presentation as part of a panel examining global marine energy test infrastructure, at the International Conference on Ocean Energy 2016, held in Edinburgh, Scotland, February 2016.
- P. Cross, L. Vega, N. Li, K. F. Cheung, R. Rocheleau, Early Research Efforts at the Navy's Wave Energy Test Site, proceedings of the 2015 Marine Energy Technology Symposium in Washington, DC. Paper presentation at conference and journal-formatted (non-peer reviewed) article, 5 pages. April, 2015.
- P. Cross, University of Hawaii Research at the Hawaii Wave Energy Test Site, proceedings of the 2014 International Conference on Ocean Energy in Halifax, NS, Canada. Paper presentation at conference and journal-formatted (non-peer reviewed) article, 6 pages. November, 2014.
- Paper presentation – August, 2003. Topic same as doctoral dissertation. American Meteorological Society Conference on Coastal Meteorology, Seattle.
- Doctoral dissertation – February, 2003. “The California Coastal Jet: Synoptic Controls and Topographic Influences”. Naval Postgraduate School. A study, using analysis of offshore buoy data and coupled ocean-atmosphere mesoscale prediction system (COAMPS) modeling, of the low-level wind flow along the California coast. Primary finding was that, in contrast to existing hydraulically supercritical channel flow explanations, flow over topography must also be considered in describing low-level wind accelerations in the lee of coastal capes and mountains.
- Paper presentation – November, 1999. Synoptic controls on the California coastal jet – an analysis of offshore buoy data in three synoptic regimes. AMS Conference on Coastal Meteorology, New Orleans.
- Paper presentation – February, 1994. Topic same as masters thesis. Oceans Conference, San Diego.
- Masters thesis – December, 1993. Ocean mixed-layer dynamics in a sea-breeze influenced upwelling regime (Monterey Bay, California). Naval Postgraduate School.