

Funding Agency: US Army Corps of Engineers, Alaska District 2204 3 rd street JBER, AK. 99506	Funding Instrument: Cooperative Agreement Funding Opportunity No: POA57AF-CESU-18-07 CFDA No: 12.632 Program Title: Legacy Resource Management Program, Sikes Act 670c-1
Issue Date: 22 August 2018	Application Due Date: 21 September 2018
<p>Overview: POA57AF-CESU 18-07 INRMP MARINE SURVEYS WAKE ISLAND AIRFIELD, USA.</p> <ol style="list-style-type: none"> 1. Overview of Marine Surveys of Wake Island. 2. Work Plan. 3. Annual Recreational Fishery Surveys. 4. Bumphead Parrotfish Surveys. 5. Sea Turtle Surveys. 6. Outreach Supply. 7. Educational Event. 8. Recreational Fisheries Report. 9. Bumphead Parrotfish Report 10. Sea Turtle Survey Report <p>See Scope of Work for detailed information.</p> <p>Period of Performance is: A total of 18 months from date of award. This requirement may be modified to extend the period of performance by one additional year if these tasks are still required and acceptable performance has been met. This does not obligate the Government to extend this agreement.</p>	
Estimated Total Funding: \$775,000	Anticipated Number of Awards: 1
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Contact Information: Questions that are related to Grants.gov including registration and system requirements should be directed to the Grants.gov contact center at 1-800-518-4726. For assistance with this funding Opportunity Announcement please contact Olen.R.Northern@usace.army.mil	

Instructions to Applicant: The complete Funding Opportunity Announcement, application forms and Instructions can be downloaded directly from Grants.gov.

Applications in response to this Funding Opportunity Announcement must be submitted by 2:00PM Alaska time, on the Application Due Date. Applications may be submitted by mail, e-mail, or via the internet through Grants.gov. Each applicant is responsible to ensure their application has been received timely.

Applicants will have a Dun and Bradstreet Data Universal Numbering System (DUNS) number, and registered

See section IV of the Funding Opportunity Announcement for complete application submission information.

Section I: Funding Opportunity Description

POA57AF-CESU 18-07 INRMP MARINE SURVEYS WAKE ISLAND AIRFIELD, USA.

Section II: Award Information

Cooperative Agreement, \$770,000, 18 month period of.

Section III: Eligibility Information

Eligible Applicants – CESU Hawaii, N&W Alaska, PNW, CA, and Colorado Plateau.

Section IV: Application and Submission Information

1. Address to Request Application Package

The complete funding opportunity announcement, application forms, and instructions are available for download at Grants.gov. USACE is not responsible for any loss of internet connectivity or for an applicant's inability to access documents posted at the referenced website.

The administrative point of contact is Olen Northern, (907) 753-2525, Olen.R.Northern@usace.army.mil.

2. Content and Form of Application Submission

All mandatory forms and any applicable optional forms must be completed in accordance with the instructions on the forms and the additional instructions below.

- a. SF 424 - Application for Federal Assistance
- b. SF 424 A – Budget Information for Non-Construction Programs
- c. SF 424 B – Assurances – Non-Construction Programs
- d. Program Narrative – Brief program description illustrating applicant's ability to meet the goals and objectives described in Section I of the announcement.

Application shall be submitted NO LATER THAN 21 SEPTEMBER-2018

3. Submission Instructions

Applications may be submitted via e-mail and, or the internet.

a. Internet:

Applicants are required to submit proposals through Grants.gov. Applicants are responsible for ensuring that their Grants.gov proposal submission is received in its entirety. The Government bears no responsibility for data errors resulting from transmission of conversion processes associated with electronic submissions. The Government will bear no responsibility for delays in submissions due to technical difficulties at or with the Grants.gov website.

All applicants using Grants.gov to submit proposals must be registered and have an account with Grants.gov. It may take up to three weeks to complete Grants.gov registration. For more information on registration, go to <http://www.grants.gov/ForApplicants>.

b. E-mail:

If there is an issue with submission to Grants.gov, please contact the Corps at the email addresses below. Format all documents to print on Letter (8 ½ x 11”) paper. E-mail proposal to Olen.R.Northern@usace.army.mil

Section V: Application Review Information

1. Evaluation for Selection to receive consideration for award, the proposal must meet the requirements set forth in this FOA and be presented with adequate detail to assure the evaluator(s) have a good understanding of the proposed requirement(s). All proposals will be evaluated to determine the extent to which each offeror demonstrates a clear understanding of the requirements of the announcement, Scope of Work (SOW), and FOA.

The offeror shall submit a proposal that completely addresses all evaluation criteria and specifically identifies how each requirement will be satisfied. Technical proposal shall be no longer than 15-pages, font 12 (This page limitation is in addition to all required forms). All questions shall be submitted no later than 5 September 2018 at 2:00PM Alaska time.

2. Basis of Award: The selection decision will be based on the NFE offering the best overall value to the Government, with consideration given to all factors described below (weighted in descending order of importance). Proposals will not be ranked. The Government will not award a Cooperative Agreement to a grantee whose proposal contains a deficiency. The selection will not be based on lowest proposed cost, it will be based on an analysis of each criteria listed below. The proposal document shall be outlined as shown below.

Proposal Submission Evaluation Criteria and Basis of Award

Integrated Natural Resources Management Plan (INRMP) Marine Surveys USAF 611 CES/CEIE Wake Island Airfield

The Government will evaluate technical proposals in accordance with the criteria described herein and award a Cooperative Agreement task order to the responsible grantee whose proposal is determined to represent the best overall value to the Government. Proposals will not be ranked. The Government will not award a Cooperative Agreement to a grantee whose proposal contains a deficiency.

The evaluation factors for this action are:

- Factor 1, 40%: Experience (most important technical factor)
- Factor 2, 35%: Technical Approach (2nd most important technical factor)
- Factor 3, 25%: Cost (reviewed after the technical package for fairness and reasonableness, and weighted against the totality of the technical factors)

After listing proposal strengths, weaknesses and deficiencies, the Government will assign an adjective rating of Outstanding, Good, Acceptable, Marginal, or Unacceptable to each technical factor which reflects the Government's confidence in each offeror's ability, as demonstrated in its proposal, to perform the requirements stated in the grant. The adjectival ratings shall be assigned, using the following criteria, which incorporate a proposal risk assessment:

Weight	Adjectival Rating	Description
4	Outstanding	Proposal indicates an exceptional approach and understanding of the requirements and contains multiple strengths.
3	Good	Proposal indicates a thorough approach and understanding of the requirements and contains at least one strength.
2	Acceptable	Proposal indicates an adequate approach and understanding of the requirements.
1	Marginal	Proposal has not demonstrated an adequate approach and understanding of the requirements or contains an element of risk.
0	Unacceptable	Proposal does not meet requirements of the solicitation and, thus, contains one or more deficiencies and is unawardable.

PROPOSAL AND SELECTION CRITERIA

The Cooperator shall be evaluated in accordance with the selection criteria below. The selection criteria are listed in descending order of importance.

Factor 1 Experience

The Cooperator shall demonstrate prior project experience relevant to the attached SOW, completed within 5 years of the RFP, and other qualifications and technical competence in all of the following areas:

- (1) Experience conducting marine aquatic species surveys.
- (2) Experience employing a systematic approach to managing wildlife resources, using inventory, monitoring, modeling, management, planning and assessment.
- (3) Planning and managing time critical work, performing studies, projects or plans in accordance with applicable guidance and regulations.
- (4) Experience supporting DoD natural resource programs.

The Cooperator shall provide examples of up to four (4) past projects of similar size, scope and complexity that best demonstrate the above qualifications. Submit projects that are at least 25% complete or were completed within the past five (5) years. The example project summaries shall be limited to one (1) page each. The example project summaries shall identify:

- Title/Subject
- Location
- Duration
- Brief description
- Roles and work self-performed
- Date project began and if completed
- Complexities or key accomplishments
- Client contact information

The Government will utilize the example project summaries to evaluate the capability and experience as a basis for comparing offerors to determine best value.

Factor 2 Technical Approach

The Cooperator shall provide a brief narrative of their technical approach and a milestone schedule. The narrative shall be no more than 1 page per main task and must include:

- A discussion of the technical approach to accomplish the performance work statement requirements, detailing number of hours anticipated to complete the project deliverables.
- A discussion of the quality assurance, quality control, and other technical activities that will be implemented to ensure that quality data are collected to support project data quality objectives

- A discussion of applicable regulatory requirements and how project requirements will be implemented.
- A discussion of all assumptions.

The Cooperator shall also provide an organizational chart with the proposed project team with defined roles, responsibilities, and lines of communication for all key personnel and sub-cooperators.

The evaluation standard has been met when the Cooperator demonstrates an understanding of the work that adequately addresses the task order requirements. The inclusion of numerous assumptions that significantly “assume away” Cooperator risk with regard to major issues or problems that may be encountered on the project will be considered unacceptable.

Factor 3 Cost

Provide proposed cost to the government. Allowable costs incurred by institutions of higher education is determined in accordance with the provision of OMB Circular A-21, "Cost Principles for Educational Institutions," ONR negotiated rates, and institutional policies. OMB's cost principles are contained in 2 CFR 200.400-.475 et seq.

Cost is considered less important than non-cost factors and will be evaluated for fairness and reasonableness per 2 CFR 200.400-.475 and OMB cost principles. If more than one proposal are rated as having equal non-cost factors, the lowest cost tender of the proposals received would be granted as the preferred tender unless there are extraordinary reasons for not doing so.

STATEMENT OF WORK (SOW)

INRMP MARINE SURVEYS WAKE ISLAND AIRFIELD, USA

August 2018

Total Project Cost Ceiling: \$775,000

1.0 INTRODUCTION

This Statement of Work (SOW) provides the details of work to be performed for the 611th Civil Engineering Squadron (CES) through a cooperative agreement (CA) administered by the US Army Corps of Engineers, Alaska District (USACE) and the Cooperator. The Cooperator shall support the Pacific Air Forces Regional Support Center (PRSC), 611 Civil Engineer Squadron (CES), Natural Resources Program, with completion of specific marine tasks within the 2017 approved INRMP. The location of the project is Wake Island.

Projects provided for execution under this CA by USACE do not include any functions to be performed that are inherently governmental. This determination is made with the assessment that places emphasis on the degree to which conditions and facts restrict the discretionary authority, decision-making responsibility, or accountability of Government officials using Cooperator services or work products.

1.1 AUTHORITY

1.1.1 In accordance with the *Sikes Act* (Sec. 103A [16 USC 670c-1]) “the Secretary of a military department may enter into cooperative agreements with States, local governments, Indian Tribes, non-governmental organizations, and individuals,..” This project is in support of the Integrated Natural Resources Management Plan (INRMP), as directed in the *Sikes Act*.

1.1.2 In agreement with the above stated goals, the Cooperator agrees to provide the necessary personnel, equipment, and materials required to implement, in part, the Pacific Air Forces Regional Support Center’s responsibilities pursuant to the Sikes Act Improvement Act (16 USC 670 et seq.), and the Endangered Species Act (16 USC 1531 et seq.).

1.1.3 In accordance with section 6305 – *Using cooperative agreements of the Federal Grant and Cooperative Agreements Act of 1977* (31 U.S.C. § 6301 et seq.), substantial involvement is expected between the Department of Defense (DOD) and the Cooperator when carrying out the activity contemplated by the cooperative agreement.

The installation agrees to provide substantial involvement to include, but not limited to, the following:

- Provide Review and comment on all written deliverables

- Provide Cooperator with Oahu based logistics and biosecurity consultant who can advise the Cooperator on proven methods of biosecurity for their marine surveys supply shipments.
- Provide Cooperator with blank medical and travel access forms they shall populate for entry to WIA and the locations to send forms to when populated.
- Provide Cooperator with names and contact information for 3rd party entities which have historically been utilized by past Cooperators for services such as vessel captain, deckhand, on island couriers, dive tank filling and maintenance, cargo transport or storage and other services typically required during marine surveys of this nature.

2.0 BACKGROUND

The PRSC manages Wake Island Airfield approximately 2,300 miles southwest from Honolulu and 1,600 miles east of Guam. The installation functions in support of contingency deployments, serves as an emergency landing facility, provides fuel storage, and supports the needs of the Department of Defense (DoD). A 1962 Executive Order 11048 designated the Secretary of the Interior responsible for all executive, legislative, and judicial authority necessary for the administration of the atoll. The civil administration of the atoll was then handed to the US Air Force through a 1972 Memoranda of Agreement between the Department of the Air Force and the Department of the Interior. To this day, the PRSC manages the atoll according to the terms and conditions of that 1972 Agreement, with one caveat – the establishment of the surrounding waters of the Pacific Remote Islands Marine National Monument (PRIMNM), which authority is delegated to the Department of Interior (DOI) and managed by the DOI as a unit of the U.S. National Wildlife Refuge System.

The Integrated Natural Resources Management Plan (INRMP) associated with Wake Island Airfield (WIA) illustrates the approaches by which the Pacific Air Forces Regional Support Center (PRSC) addresses various environmental requirements and conservation goals. The document also displays the projects the PRSC aims to implement each year and these projects afford a benefit to both the mission, as well as the terrestrial and marine flora and fauna that exists on or near the installation boundary.

3.0 OBJECTIVES

3.1 All tasks associated with this Statement of Work have a marine focus and shall be conducted at Wake Island. The execution of this project assists the USAF with completion of the following goals within the approved INRMP:

- INRMP Goal #2: Employing a systematic approach to managing wildlife resources, using a process that includes inventory, monitoring, modeling, management, planning and assessment
- INRMP Goal #4: Provide quality outdoor recreation experiences for civilian, active duty and contract work staff that do not deteriorate ecosystem integrity or the USAF mission

- INRMP Goal #6: Manage Wake Island using a regional ecosystem-based approach that manages sensitive species and their associated ecosystems while protecting the operational functionality of the sites missions

4.0 MAJOR REQUIREMENTS AND TASKS

4.1 Overview of Marine Surveys of Wake Island

The Cooperator shall conduct a series of surveys at WIA that focus on fish species surrounding the atoll as well as sea turtles. The three survey types include: annual recreational fishery surveys, Bumphead parrotfish surveys, and sea turtle surveys. The recreational fisheries surveys shall utilize the methodologies of predecessor site visits in order to ensure data are comparable across years. The fisheries surveys shall focus on not only commonly harvested sport fish targets, but also non-target species which are incidentally caught.

In 2018, USAF funding was issued to the Bishop Museum to conduct the atoll's first year of data collection under the revised recreational fishing program, instituted under the 2017 INRMP. The methods used by the Bishop Museum as described in **Reference A** shall be replicated by the Cooperator to the greatest extent for the recreational fisheries surveys.

There is interest from the command to continue tracking the atolls bumphead parrotfish populations in surrounding waters, given the rare nature of the species and its sensitivity to human impacts elsewhere in its range. In 2011, population estimates were documented based on surveys of the surrounding waters of the atoll. The resulting publication, **Reference B**, shall be used by the Cooperator to replicate the survey methods and approach for this specific species survey, so as to compare results across years. The bumphead parrotfish surveys will be specific to this species and shall result in a population estimate or index that can be tracked in future years.

The third and final survey type is a sea turtle survey. The command would like more information about the species of turtle, the sex ratio, and the age classes of sea turtles using Wake Island. In addition, further detail on how long they reside in waters near wake and where they venture to prior or before arriving to Wake Island is also of interest. This data can be captured using satellite tag technology. Sea turtle data yielded from this project shall be used by the USAF in future years for impact analysis exercises in alignment with the National Environmental Policy Act and Endangered Species Act.

4.2 Workplan

The Workplan (**deliverable A**) shall display how, where and when major project tasks will be completed over the course of the period of performance. The draft work plan shall address all three survey tasks required for implementation and those surveys include: (1) annual recreational fishery surveys, (2) Bumphead parrotfish surveys, and (3) sea turtle surveys. The content within the workplan shall help a reader understand how all tasks within this SOW will be conducted. The Cooperator shall populate a Project Planning Chart (PPC) or Gantt chart within the draft work plan and use this tool to illustrate the project schedule. A list of all project staff and their

roles, inclusive of any sub-contract efforts involved in this project shall be portrayed in this Work Plan. Draft maps of proposed survey areas shall be included in the draft work plan.

The Draft Work Plan shall also outline the requirements to be included in any necessary sub-agreements with the WIA Base Operating Support (BOS) contractor or other sub-contractor. It is recommended that the following items be included in such sub-agreement: logistical support for the movement of any cargo to and from Wake, billeting and meals while on Wake, rental of a BOS contractor truck or vehicle for transport on island, lodging, transportation on and off Hickam Air Force Base, filling of air tanks, and usage of on island tools that cannot be shipped. A list of supplies, materials, diving gear, and forecasted manpower to implement this SOW should also be depicted within the draft workplan when discussing elements of the project, alongside the projected costs of those items. The Cooperator shall highlight those items which are being implemented by another entity via sub agreement or sub contract within the draft workplan, such that the reader can understand the extent by which other entities will be involved in the project. The Cooperator shall submit the draft workplan to the government no later than 90 days after award. The government shall provide the Cooperator with comments on the draft work plan within 15 calendar days of receipt of draft work plan.

The Cooperator shall utilize the government comments to make edits and changes to the Final Work Plan (**deliverable A1**). A response to each government comment shall be documented by the Cooperator within a response to comment matrix. The populated comment matrix (**deliverable A2**) shall be submitted alongside the Final Work Plan (**deliverable A1**) within 15 calendar days from the day the government comments were received.

4.3 Annual Recreational Fishery Surveys

The Cooperator shall replicate the methods identified in **Reference A** and collect both target and non-target fish data. Methods used to accomplish this task shall be in accordance with the approved work plan. A Coast Guard certified captain shall be required for outer reef sampling, along with one committed deckhand. The captain and deckhand shall have prior experience operating fishing vessels in remote pelagic waters. The captain and deckhand shall complete safety briefings every morning in order to acquaint the team with safety measures and emergency operations in the event of a potential accident. The Cooperator shall be responsible for procuring supplies and getting them to WIA to accomplish this task. The Cooperator is responsible to obtain rental vehicles, vehicle fuel, hotel, boat fuel, meals, flights, shipping, logistics support, and on island freezer usage and other services should the Cooperator lack them. It is recommended that the Cooperator utilizes a sub-contractor for on island transportation, vessel rental, tank fills, and shore-side labor if the Cooperator lacks such team members and logistical expertise. The survey methods shall ensure that future biological surveys can compare data amongst years, thus replication and objectivity are important themes for the methods to encompass. A detailed description of the methods used to capture fish, index or census their population, and evaluate the health of the species communities shall be documented in a draft and final project report. All sea turtle sightings captured during this task, shall be recorded and portrayed in an anecdotal sightings sections of the draft and final report. The methods and analysis of choice for this specific survey, shall afford the 611th the ability to compare future years data against the data collected under this effort. The data generated from this effort shall be

used by the Cooperator to evaluate whether a target or non-target group is experiencing a population decline or other form of impact due to fishing or other stressor. All surveys, species locations, and other valuable data shall be memorialized using geographic information systems (GIS) technologies. GIS associated with this task shall be submitted alongside **Deliverable C1**.

4.4 Bumphead Parrotfish Surveys

Wake Island and its surrounding waters provide habitat for vulnerable species such as the giant bumphead parrotfish (*Bolbometopon muricatum*). In 2011, a focused survey confirmed the continued presence of the species and documented increased densities along the Southwest side of the atoll. The Cooperator shall mimic the methods described within **Reference B** and summarize data in a manner by which it is comparable with the results depicted within **Reference B**. Areas surveyed in 2011, shall be re-visited, with an emphasis placed on the southwest portion of the atoll. All sea turtle sightings captured during this task, shall be recorded and portrayed in an anecdotal sightings sections of the draft and final report. A coast guard certified captain shall be required for outer reef sampling, along with one committed deckhand. The captain and deckhand shall have prior experience operating fishing vessels in remote pelagic waters. The captain and deckhand shall complete safety briefings every morning in order to acquaint the team with safety measures and emergency operations in the event of a potential accident. The Cooperator shall be responsible for procuring supplies and getting them to WIA to accomplish this task. The Cooperator is responsible to obtain rental vehicles, vehicle fuel, hotel, boat fuel, meals, flights, shipping, logistics support, and on island freezer usage and other services should the Cooperator lack them. It is recommended that Cooperator utilizes a sub-contractor for on island transportation, vessel rental, tank fills, and shore-side labor if the Cooperator lacks such team members and logistical expertise. All surveys, species locations, and other valuable data shall be memorialized using geographic information systems (GIS) technologies. GIS associated with this task shall be submitted alongside **Deliverable D1**.

4.5 Sea Turtle Surveys

Sea turtles have been documented within the waters surrounding Wake Island, however little information is known about the individuals which utilize these waters for a portion for their lives. This task shall provide information to address the following four data gaps: (1) amount of time each individual spends in the vicinity, (2) their individual movements before and after arrival to the atoll's surrounding reefs and lagoon, (3) their daily habits while in waters surrounding wake and finally (4) their respective physical condition, fitness, age and sex. This information is needed in order for accurate and comprehensive conclusions of effect to be derived when attempting to identify how federal actions will or will not negatively impact a species. The Cooperator shall use satellite tracking capabilities to capture information to assist with the 4 data gaps for the populations of sea turtles utilizing the area. The Cooperator is responsible for acquiring all permits associated with implementing this task and shall invite the USAF and ACOE Cooperator to all engagements and email communications involving permit actions, applications, or discussions. All required federal consultations and permit applications and their associated management is the responsibility of the Cooperator. All equipment required to complete this task, inclusive of satellite transmitters, and any associated technology shall be acquired by the Cooperator and transported to the Wake Island Airfield. A coast guard certified

captain shall be required for areas outside the lagoon, along with one committed deckhand. The captain and deckhand shall have prior experience operating fishing vessels in remote pelagic waters. The captain and deckhand shall complete safety briefings every morning in order to acquaint the team with safety measures and emergency operations in the event of a potential accident. The Cooperator shall be responsible for procuring supplies and getting them to WIA to accomplish this task. The Cooperator is responsible to obtain rental vehicles, vehicle fuel, hotel, boat fuel, meals, flights, shipping, logistics support, and on island freezer usage and other services should the Cooperator lack them. It is recommended that Cooperator utilizes a sub-contractor for on island transportation, vessel rental, tank fills, and shore-side labor if the Cooperator lacks such team members and logistical expertise. All surveys, species locations, and other valuable data shall be memorialized using geographic information systems (GIS) technologies. GIS associated with this task shall be submitted alongside **Deliverable E1**.

4.6 Outreach Supply

In support of the outreach event, the Cooperator shall procure, transport and disperse the following materials to those who attend the volunteer outreach event: hats, long sleeve wicker UV shirts, and letters of educational certification recording their attendance. Logos to be used on the shirts shall be depicted within the draft and final workplan. The vendors used to procure the supplies shall be listed within the workplan along with a budget of the cost for the supplies and their respective unit cost, as well as shipping costs. An estimate of approximately 200 attendees is appropriate for this event. Supplies shall provide the estimated 200 attendees one item each; leftover supplies shall be left on island to be used for future outreach events. The Cooperator is responsible for procuring the supplies and shipping them to Wake Island for dispersal at the educational event. An inventory and image of each type outreach supply to be used during the educational event shall be depicted within **Deliverable A and Deliverable A1**.

4.7 Educational Event

While on island, the Cooperator shall schedule an all hands educational fisheries event with the Islands community. Prior to arriving on the island, the COOPERATOR shall coordinate a date and time for such event with the islands Commander and (Base Operations Support) BOS contractor site manager. The Cooperator shall identify the date of the outreach event within their draft work plan schedule. The outreach event shall be catered towards those who intend to fish while living on the atoll, with an emphasis on reef and lagoon fishing practices. Mandatory attendance during weekends is not something the government can enforce the BOS contractor to perform, thus the Cooperator shall utilize voluntary language in all advertisements for this event and ensure the event falls on a non-work day for the on island BOS contractor staff. The outreach event shall instruct attendees to perform the following: careful release, fish identification, safe hook removal, measuring techniques, how to populate the PRSC's recreational fishing survey forms, and a review of common scientific fish terms which appear on the creel survey forms. Prior to completion of the outreach event, the Cooperator shall log the names of all participants and depict such name attendance sheet within the draft project report. Pictures shall be taken by the Cooperator during the outreach event, in order to photo-document the event. Presentation material utilized during the event and the efficacy of such training shall be discussed within the Draft and Final Fisheries Project Report. A draft outreach event program depicting the outreach

events composition, materials to be presented, instructors, and complete schedule shall be submitted alongside the draft work plan within 90 calendar days of award. The draft outreach event program shall be defined as “**Deliverable B**”. The 611 CES, will have 28 days to review and provide comments on the draft outreach event program within a matrix. The government comments will be issued to the Cooperator within 28 days of receipt of Deliverable B. The Cooperator shall address the 611 CES comments and alter their draft outreach program within 15 calendar days of receipt of 611th CES comment and return a final outreach program to the 611th CES, alongside a response to comment matrix displaying how each comment was addressed. The Final Outreach program shall be defined as final, once accepted by the 611th CES. The final outreach program shall be defined as “**Deliverable B1**”, while the populated comment matrix deemed “**Deliverable B2**”.

4.8 Recreational Fisheries Report

Data collected during the recreational fisheries surveys which detail the status of target and non-target Fish species shall be analyzed to provide a quantitative assessment of the population status and condition of each fish species. The Cooperator shall also integrate comparisons to other tropical locations so as to give the reader an understanding as to how the data collected at WIA does or does not differ from data collected elsewhere on similar species or the same species. The draft reports shall utilize the Journal of Wildlife Management format for article submissions. An Executive Summary shall also be created and submitted as part of the draft and final report. Recommendations for future teams who will sample fish populations in future years shall be included in the draft report. GIS generated maps shall be included in the report depicting locations of sampling. Level of effort shall be quantified using time (hours) so as to give the reader an understanding of what level of effort yielding the sample sizes depicted in the report. The methods section of the draft report shall grant a reader the ability to track how the biologists collected their data in an unbiased fashion. The Cooperator shall submit a draft project report no later than 420 calendar days after the award date. The installation shall be granted 15 calendar days to provide the Cooperator with comments on their respective draft project report. The draft project report shall be deemed “**Deliverable C**”.

The Cooperator shall address the 611 CES comments and alter their recreational fisheries project report within 15 calendar days of receipt of 611th CES comment and return a final project Report to the 611th CES, alongside a response to comment matrix displaying how each comment was addressed in the Final Project Report. The Fisheries Project Report shall be defined as final, once accepted by the 611th CES. The final report shall be deemed “**Deliverable C1**”, while the populated comment matrix shall be deemed “**Deliverable C2**”.

4.9 Bumphead Parrotfish Report

All information gathered during the Parrotfish Surveys shall be analyzed to provide a quantitative assessment of the population status and condition of fish species. The Cooperator shall also integrate comparisons to other tropical locations so as to give the reader an understanding as to how the data collected at WIA does or does not differ from data collected elsewhere on similar species or the same species. The draft reports shall utilize the Journal of Wildlife Management format for article submissions. An Executive Summary shall also be

created and submitted as part of the draft and final report. Recommendations for future teams who will sample fish populations in future years shall be included in the draft report. GIS generated maps shall be included in the report depicting locations of Bumphead parrotfish as well as GIS track lines displaying areas surveyed. Level of effort shall be quantified using time (hours) so as to give the reader an understanding of what level of effort yielding the sample sizes and areas surveyed as depicted in the report. The methods section of the draft report shall grant a reader the ability to track how the biologists collected their data in an unbiased fashion. The Cooperator shall submit a draft project report no later than 420 calendar days after the award date. The installation shall be granted 15 calendar days to provide the COOPERATOR with comments on their respective draft project report. The draft bumphead parrotfish project report shall be deemed “**Deliverable D**”.

The Cooperator shall address the 611 CES comments and alter their draft bumphead parrotfish project report within 15 calendar days of receipt of 611th CES comment and return a final project Report to the 611th CES, alongside a response to comment matrix displaying how each comment was addressed in the Final Bumphead Parrotfish Report. The Final Bumphead Parrotfish Report shall be defined as final, once accepted by the 611th CES. The final report shall be deemed “**Deliverable D1**”, while the populated comment matrix deemed “**Deliverable D2**”.

4.10 Sea Turtle Survey Report

All information gathered during the Sea Turtle Surveys shall be analyzed to provide a quantitative assessment of the populations status and provide information to fill the following data gaps: (1) amount of time each individual spends using the atolls near shore waters, (2) their individual movements before and after arrival to the atoll’s surrounding reefs and lagoon, (3) their daily habits while in waters surrounding wake and finally (4) their respective physical condition, fitness, age and sex. The Cooperator shall also integrate comparisons to other tropical locations so as to give the reader an understanding as to how the data collected at WIA does or does not differ from data collected elsewhere on similar species or the same species. The draft reports shall utilize the Journal of Wildlife Management format for article submissions. An Executive Summary shall also be created and submitted as part of the draft and final report. Recommendations for future teams who will sample turtle populations in future years shall be included in the draft report. GIS generated maps shall be included in the report depicting locations of sea turtles as well as GIS track lines displaying areas surveyed. Level of effort shall be quantified using time (hours) so as to give the reader an understanding of what level of effort yielding the sample sizes and areas surveyed as depicted in the report. The methods section of the draft report shall grant a reader the ability to track how the biologists collected their data in an unbiased fashion. The Cooperator shall submit a draft sea turtle survey project report no later than 420 calendar days after the award date. The installation shall be granted 15 calendar days to provide the Cooperator with comments on their respective draft project report. The draft sea turtle survey project report shall be deemed “**Deliverable E**”.

The Cooperator shall address the 611 CES comments and alter their draft sea turtle survey project report within 15 calendar days of receipt of 611th CES comment and return a final project Report to the 611th CES, alongside a response to comment matrix displaying how each

comment was addressed in the Final Project Report. The Final Sea Turtle Report shall be defined as final, once accepted by the 611th CES. The final sea turtle survey report shall be deemed “**Deliverable E1**”, while the populated comment matrix shall be deemed “**Deliverable E2**”.

5.0 REPORTS, DELIVERABLES, and SCHEDULE

5.1 Deliverable Schedule:

Deliverable Number	Deliverable Title	Submission Schedule
Deliverable A	Draft Work Plan	Deliverable A: Within 90 calendar days of award
Deliverable A1, A2	Final Work Plan & Comment Response Matrix	Deliverable A1 and A2: Within 15 calendar days of receiving government comments
Deliverable B	Draft Outreach Program	Deliverable B: Within 90 calendar days of Task Order Award
Deliverable B1, B2	Final Outreach Program & Comment Response Matrix	Deliverable B1 and B2: Within 15 calendar days of receiving government comments
Deliverable C	Draft Recreational Fisheries Report	Deliverable C: Within 420 calendar days of award
Deliverable C1, C2	Final Recreational Fisheries Report & Comment Response Matrix	Deliverable C1: Within 15 calendar days of receiving government comments
Deliverable D	Draft Bumphead Parrotfish Report	Deliverable D: Within 420 calendar days of receiving government comments
Deliverable D1, D2	Final Bumphead Parrotfish Report & Comment Response Matrix	Deliverable D1 and D2: Within 15 calendar days of receiving government comments
Deliverable E	Draft Sea Turtle Survey Report	Deliverable E1: Within 420 calendar days of receiving government comments
Deliverable E1, E2	Final Sea Turtle Survey Report & Comment Response Matrix	Deliverable F: Within 15 calendar days of receiving government comments

5.2 The Cooperator shall submit Monthly Progress Reports summarizing activities to the USACE Project Manager, and AF point of contact. Monthly progress reports will include assessment and investigation activities and anticipated work for the following month.

6.0 TRAVEL AND LOGISTICS

6.1 The 611 CES Project Manager will support the Cooperator in securing travel approval to and from WIA provided that the Cooperator and all field staff have appropriate identification and documentation (i.e. passports). All persons wishing to be granted access to Wake Island will obtain Entry Authorizations and Travel Orders (also referred to as Letter of Introduction) from the 611 CES, Natural Resources Project Manager.

7.0 GIS REQUIREMENTS

7.1 The project surveys and associated deliverables require the need for GIS data to be collected and submitted; the following guidance is provided for completing environmental GIS data development or performing GPS surveys and inventories of environmental data:

- The contractor will develop GIS data to comply with the applicable Data Layer Specifications provided on the Environmental GIS eDASH page.
- The contractor will utilize the SDSFIE 3.1 USAF compliant template provided on the Environmental GIS eDASH page.
- The contractor is responsible for delivering the spatial data in the applicable Universal Transverse Mercator (UTM) coordinate system, World Geodetic System 1984 (WGS84) datum and spheroid according to the attached list.
- The contractor will coordinate with the Environmental GIS Analyst to determine the current version being used for all software, data and data standards.

If additional questions arise or more information is required contractors should coordinate with the Environmental GIS Analyst. **GIS data will be transmitted to the government via the file transfer site: <https://safe.amrdec.army.mil/SAFE/>.**

8.0 EQUIPMENT, SUPPLIES AND LOGISTICS

8.1 All supplies and materials required to complete the SOW must be purchased by the Cooperator, and the 611 CES shall be provided the opportunity to retain all supplies and equipment purchased for this project. Shipping of any materials necessary for the project shall be done so at the cost of the Cooperator and will be done via barge or air cargo movements to Wake Island. The airlift Customer Identification Code (CIC) will be obtained by the Cooperator and be utilized for air cargo shipping payments. The government reserves the right to take possession of all supplies used during this project, if it so requests after completion of all tasks. This reservation does not relieve the Cooperator from demobilization and clean up after completion of tasks and site visits.

8.2 The Cooperator must work with the 611 CES Natural Resources Project Manager and BOS contractor to coordinate on other general matters. Examples of the offices/departments that the Cooperator shall coordinate activities with include, but are not limited to:

The Cooperator will be required to make arrangements for the use of a contractor vehicle while on Wake Island. The 611 CES, Project Manager will provide to the point of contact for this arrangements, for proposal purposes the Cooperator should utilize local Hawaii car rental rates for a baseline cost for vehicle rentals on Wake. The Cooperator does not need to make billeting arrangements, these will be automatic arranged by the base operating support contractor. There is no cellular phone service available on Wake, internet accessibility is also limited, and the Cooperator shall plan accordingly. All flights to WIA depart from the JBPHH terminal building, the Cooperator will ensure proper access to JBPHH has been arranged well in advance of the flight departure, this may require up to eight weeks of processing time by the JBPHH security office (if the Cooperators do not have Federal ID Assess cards).

8.3 The Cooperator is required to notify the AF Technical POC and the USACE Project Manager of critical issues that may affect the project performance and/or human health and the environment. The types of issues that require notification include, but are not limited to, health risks, spills, unexpected utility crossings, unusual weather conditions, unacceptable materials, changes in critical personnel, and Unexploded Ordinance (UXO). On critical issues, oral notification should be made immediately, followed by written notification as soon as practical.

9.0 MEDIA CONTACT AND PUBLICATION OF DATA

All reports and data generated under this contract are the property of the government and distribution by the Cooperator to any source, unless previously authorized by the 611 CES, is prohibited. The Cooperator shall not make available to the news media or publicly disclose any data generated or reviewed under this contract. If approached by the news media, the Cooperator shall refer them to the AF Technical POC for response. Project reports and data generated under this contract shall become the property of the government and distribution to any other source by the Cooperator is prohibited. In the event the Cooperator decides to publish findings which utilize field data from this award, the Cooperator agrees to share a draft version of the publication with the 611 CES project manager prior to submitting to a journal body. The government reserves the right to review the Cooperator's proposed publications and approve or deny publication of data collected subject to the provisions of the Freedom of Information Act (FOIA). As such all data produced as a result of project work is accessible to the public unless specifically exempted under FOIA due to personal privacy, national security, and/or law enforcement.

10.0 PERIOD OF PERFORMANCE

The period of performance for this task order is 18 months from date of award.

11.0 POINTS OF CONTACT

11.1 The USAF Technical POC is Joel Helm. Routine correspondence should be via email when appropriate.

Joel Helm
U.S. Air Force 611 CES/CEIE
10471 20th Street Suite 302
JBER, AK 99506-2201
Phone: 907-552-5230
Email: joel.helm.1@us.af.mil

11.2 The POC for USACE Project Management is Charis Cooper. Cooperative Agreement questions should be addressed to the Grants Officer, Olen Northern. Correspondence should be addressed as follows:

Charis Cooper
U.S. Army Corps of Engineers
Environmental & Special Projects Branch
ATTN: CEPOA-EC-EE
P.O. Box 6898
JBER, AK 99506-0898
Office: (907) 753-5692
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Olen Northern
U.S. Army Corps of Engineers
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WAKE ATOLL BASELINE FISHERY SURVEYS WORK PLAN (DRAFT)

Agreement No. W9128F-17-2-0029
Project No. YGFZOS173456

Prepared for:

The United States of America
US Army Corps Engineers, Omaha District
1616 Capitol Ave.
Omaha, Nebraska 68102

Prepared by:



1525 Bernice Street
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ACRONYMS AND ABBREVIATIONS

BMP	Best management practice
BPBM	Bernice Pauahi Bishop Museum
BOS	Base Operations Support
CES	Civil Engineer Squadron
CFSI	Chugach Federal Solutions, Inc.
CPUE	Catch per unit effort
INRMP	Integrated Resources Management Plan
m	meter(s)
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service
PACAF	Pacific Air Force Command
PRSC	Pacific Air Forces Regional Support Center
SPC	Stationary Point Count
SOW	Scope of Work
U.S.	United States
USAF	United States Air Force
USACE	United States Army Corps of Engineers
USCBP	United States Customs and Border Patrol
USFWS	U.S. Fish and Wildlife Service
WIA	Wake Island Air Field
WP	Work Plan

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1. INTRODUCTION AND PURPOSE

The Bernice Pauahi Bishop Museum (BPBM) is supporting the Wake Atoll Baseline Fishery Surveys for Wake Island Airfield (WIA) (Project No. YGFZOS173456). The purpose of this project is to conduct marine fisheries surveys as described in the project tasks herein to support the Department of Defense natural resource planning at WIA. This project is being performed in support of the coastal zone management goals developed for WIA as part of the Integrated Natural Resource Management Plan (INRMP) prepared by the United States (U.S.) Air Force (USAF) 611th Civil Engineer Squadron (CES) (USAF, 2017). These baseline fishery surveys are designed to provide the data need to ensure that recreational activities do not have adverse impacts on submerged lands and corals associated with Wake Atoll. This Work Plan (WP) satisfies U.S. Army Corps of Engineers (USACE) Scope of Work (SOW), dated 30 August 2017, deliverable A.

1.1 Regulatory Drivers

Regulatory drivers for this fishery survey project include the Sykes Act; the U.S. Endangered Species Act; Proclamation 8336, which establishes Pacific Remote Islands Marine National Monument; and the National Wildlife Refuge Improvement Act. Part of the goal of this project is assessing how the WIA resources may be managed in concert with the aforementioned regulatory drivers and mission for associated uses. Residents and visiting contractors to Wake Atoll who actively engage in recreational activities in shoreline areas and adjacent submerged lands have the potential to adversely impact marine resources if management practices are not in place to ensure impacts do not occur. Data from the fishery surveys will provide an important foundation for future resource planning.

1.2 Development of Baseline

To support the coastal zone management objectives developed in the INRMP, BPBM will conduct fish surveys at Wake Atoll to serve as a baseline reference to allow future monitoring of selected species targeted by recreational fishing, as well as non-targeted species that may be incidentally taken.

To establish a reliable baseline, two different general survey techniques will be employed. The first involves several standardized capture techniques commonly used on Wake Atoll, including cast nets in shallow shoreline habitats and several kinds of hook and line capture techniques on nearshore and offshore habitats. The second technique involves standard quantitative in-water surveys performed by divers to measure the abundance of both target species and non-target species, including a more general assessment of species assemblages across a range of exploited coral-reef habitats.

1.3 Education Materials

In addition to the quantitative baseline surveys, BPBM will organize an Outreach and Education event on Wake Atoll to help educate people who conduct recreational fishing activities on Wake Atoll on sustainable fishing practices, and will include information on fish identification, safe hook removal and other careful release methods, measuring techniques, and how to accurately complete the recreational fishing survey forms (including a review of common scientific fish terms which appear on these forms). BPBM will also construct an educational kiosk with video and graphic media materials presented in both Thai and English languages that will be located in the lobby of the Wake Island airport terminal.

2. BACKGROUND

The current state of the fishery at Wake Atoll is considered undeveloped and the fishery is essentially a recreation use only resource available only to the inhabitants of and visitors to Wake Atoll. Organized commercial fishing is not permitted on Wake and due to its remote location and control by the USAF, unlawful sport or commercial fishing does not occur. Additionally, recreational fishing at Wake, which is primarily limited to hook and line fishing from shore, is largely catch and release, with some species of fish being occasionally taken for consumption by the resident military and contractor population. Export of fish tissue or other marine life from Wake is prohibited and all cargo shipments from Wake are heavily monitored by the United States Customs and Border Patrol (USCBP). As a result of the military mission and remoteness of Wake Atoll the fishery is strictly recreation use only and accessible to a very limited population which includes military personnel, resident contractors, and visiting contractors. The USAF has been managing this resource carefully and has been looking at developing a better understanding of the limited fishing activities on the overall marine resource.

2.1 INRMP Goals

In 2017, the USAF completed an INRMP that evaluated both terrestrial and marine resources on Wake Atoll (Levenson 2008). Among the features for the management of marine resources at Wake Atoll are a series of Coastal Zone and Marine Resource Management Goals, including the development and implementation of a systematic approach to managing wildlife resources using a process that includes inventory, monitoring, modeling, management, and assessment (Objective Fish and Wildlife Management - 4 of the 2017 INRMP). A key component of this objective is to support the assessment of the effects of recreational fishing on the on Wake Atoll in order the support development of appropriate management approaches for the resource. In support of this objective the following tasks were identified:

Draft Wake Atoll Baseline Fishery Surveys Work Plan

1. Conduct lagoon and offshore surveys of fish populations. Specifically, those species that are most commonly consumed by residents.
2. Quantify results from the surveys in a report and summarize the impact from 12 months fishing at the Atoll.
3. The USFWS, National Marine Fisheries Service (NMFS), and the Pacific Air Forces Regional Support Center (PRSC) will work together to develop goals for protecting reef species in conjunction with recreation fishery.
4. A fishery biologist with experience in assessing population dynamics should be brought into this project to help craft improved data collection log, assess target species populations, and establish species recovery goals.

The monitoring criteria include both lagoon and offshore surveys of fish populations, and the preparation of a summary report on the impacts to the fish populations every 12 months.

It is the policy of the USAF to make lands accessible to the public for educational and sustainable recreational use of natural and cultural resources when such access is compatible with military mission activities. Residents and visiting contractors to Wake Atoll actively engage in hiking, beach combing, snorkeling, SCUBA diving, boating, and fishing. Recreational activities in shoreline areas and adjacent submerged lands have the potential to adversely impact marine resources if management practices are not in place to ensure impacts do not occur.

The INRMP identified that a formal Outdoor Recreation Plan to support management of natural resources for recreational activities was needed for Wake Atoll and the USAF subsequently has recently completed the Wake Island Operating Guidance for the Environmental Compliance and Protection of Natural Resources in April 2017.

The Wake Island Operating Guidance outlines the areas that are restricted for use; endangered terrestrial and marine resources; guidelines for allowable recreational fishing methods, restricted and permitted target species, and locations off-limits to reef and pelagic fisheries; as well as other resources where that take is prohibited and those that are permitted in accordance with the Wake Island Operating Guidance (USAF approval), and/or U.S. Fish and Wildlife Service (USFWS) approval.

The Wake Island Operating Guidance allows a limited level of recreational shore fishing for “catch and release” and limited on-island consumption is permitted as long as the fisherman complete a USAF/PRSC – Wake Atoll Fishing Log. The fishing log is required for residents and visiting contractors that participate in any fishing activity and is intended to track the number of fishers, gear types used, level of effort, and harvest information. This information is also provided to USFWS and NOAA. Allowable gear includes rod and reel, Hawaiian sling spear, and cast nets for baitfish collection. The allowable offshore fishing areas and allowable target pelagic fish species are also outlined in the Operating Guidance. Pelagic fishers are also required to complete USAF/PRSC – Wake Island Fishing Log. In support of USAF marine resource recreation use policy, the INRMP also identified another key objective to the Coastal and Marine Management Goals which included implementing a fishing permit system to

track fishing pressure on Wake Atoll (Objective Outdoor Resource - 2 of the 2017 INRMP).

A key component of this objective OR-2 was achieved by the development of the Wake Atoll Operating Guidance which serves to educate recreational users of the marine environment and establishes guidelines to support the sustainable use of the marine ecosystem. Another key component of this objective is to support the assessment of the effects of recreational fishing on the on Wake Atoll to support the development of appropriate management approaches for the resource. In support of this objective the following tasks were identified:

1. Ensure that personnel fishing on Wake Atoll are aware of and follow the guidelines in the Wake Island Operating Plan.
2. Include information regarding the fishing program and associated requirements in the newcomers' orientation to Wake Atoll.
3. Gather USAF/PRSC – Wake Atoll Fishing Logs and prepare an annual report for the submission to USFWS.
4. Monitor island fishing activities to ensure compliance with the Wake Island Operating Guidance.

2.2 Previous Studies

Several priorities identified by the INRMP that relate to the Coastal Zone Marine Resource Management Goals have also been addressed in earlier studies, briefly summarized below:

- 1999 - Baseline Marine Biological Survey in the vicinity of Peacock Point conducted jointly by the USFWS and the NMFS (USFWS and NMFS 1999). This study documented the primary species of reef fishes, corals, other macroinvertebrates, and algae
- 2002 – Fish tissue sampling in the Wake Island Lagoon as part of a human health risk screening evaluation (USAF 2002). Sampled bonefish, damselfish, goatfish, and squirrelfish
- 2005 - Reef Assessment and Monitoring activities were initiated at Wake Atoll conducted by NOAA Pacific Islands Fisheries Science Center's Coral Reef Ecosystems Division (Brainard et al 2008)
- 2010 and 2013 – Fish tissue sampling and biological surveys of intertidal community abundance and composition at the Peacock Point Dump Site to assess how benthic and epibenthic communities had recolonized at the site since the materials at the reef dumpsite were removed (EA 2013). These were compared to data collected in 2010 prior to the removal of debris in 2012 (CH2M Hill 2010)
- 2012 – Fishing tissue sampling following the rat eradication project to evaluate fish tissue for the presence of brodifacoum (rat bait) used to poison the rats. Study collected fish seven popular fishing locations and analyzed them for presence of brodifacoum

- 2013 – Reef Assessment and Monitoring by NOAA using broad-scale towed-diver surveys were conducted in shallow water benthic habitats as well as site-specific surveys to assess composition, percent cover, size distribution, of salient benthic organisms including corals (Kenyon et al. 2013), and
- 2014 - NOAA Pacific Islands Fisheries Science Center’s Coral Reef Ecosystems Division conducted studies on Wake Atolls coral reef ecosystem. Objective was to conduct a Rapid Ecological Assessment of reef fishes, corals, other invertebrates, and algae and to retrieve and replace the Autonomous Reef Monitoring structures there previously deployed in earlier studies

3. PROJECT APPROACH

In support of the objectives outlined above, and in fulfillment of Tasks 1 and 2 of the Statement of Work (SOW) for the Wake Atoll Fishery Survey, BPBM will develop a plan and conduct baseline surveys of fishes at Wake Atoll, to establish a starting point for future comparisons that will focus on both target and “non-target” species for both nearshore (lagoon and reef areas) species and offshore pelagic species. Specific survey locations selected for this study will include locations where the previous work has been done, common fishing areas, and other areas identified by bathymetric analysis, in order to facilitate reasonable and repeatable monitoring in the future. BPBM will employ well-established survey techniques that are consistent with those used by the USFWS, NOAA, and NMFS. Our analysis will incorporate data already obtained from previous studies as described above to results of this baseline study. BPBM will include statistical transect, grid survey methods fisheries quality through application of conventional catch observation type survey methods.

In addition to the baseline survey work, BPBM will also develop educational and outreach materials as described in the 2017 INRMP Goal OR-2 (referenced above) and outlined in Tasks 3 and 4 of the SOW. BPBM is uniquely qualified to design educational materials and implement the educational component and has extensive expertise in designing and developing video media materials, including the development of video-based informational kiosks (SOW Task 4).

All results will be synthesized and provided to 611th CES in the form of a draft report and final report, as indicated in the SOW (Tasks 5 & 6).

A detailed Gantt chart depicting timing of project tasks and deliverable submission dates is presented in Appendix A.

3.1 Logistics

Offshore fisheries sampling and monitoring requiring a vessel and coast guard certified captain will be provided by Chugach Federal Solutions, Inc. (CFSI). The BPBM team will provide all fishing, diving, and sampling equipment and utilize CFSI’s air transport and barge service to move all supplies from Honolulu to Wake Atoll.

The BPBM survey methods will ensure that future biological surveys can compare data amongst years, thus using the services of CFSI, services and equipment required through their master contract with USAF, help to ensure that replication can be achieved in future follow-up surveys. BPBM Team includes staff from their subcontractor Kealamahi Pacific Consulting, LLC (KPC).

3.2 Project Team

Sarah Miller, USACE Omaha Project Manager
Joel Helm, USAF 611th CES Natural Resource Program Manager
Kristen Rex, USAF 611th CES Natural Resource
Richard L. Pyle Ph.D., BPBM Principal Investigator
Brian D. Greene, BPBM Diver and Fish Expert
Scott Moncrief, KPC, Fisheries Technical Resource/Senior Scientist
Noah Kippen, KPC, Deck Hand for Vessel Surveys

The captain and deckhand will complete safety briefings every morning in order to acquaint the team with safety measures and emergency operations in the event of a potential accident.

4. FISH SURVEYS

BPBM will collect and/or observe the fish species identified in Section 1.0 of the SOW in addition to a host of non-target species that are representative of other feeding guilds. Target species will include bonefishes (*Albula* spp.), bluefin trevally (*Caranx melampygus*), goatfish species (Mullidae), commonly eaten snapper species (Lutjanidae) and a variety of other commonly sought-after food fish (e.g., Aholehole [*Kuhlia* sp.], parrotfish [*Scarus* sp. and *Chlorurus* sp. varieties], and a variety of surgeon fish [Acanthuridae]). Non-target species will include humphead wrasse (*Cheilinus undulatus*), bumphead parrotfish (*Bolbometopon muricatum*), and other species. Key features of the BPBM baseline survey include:

- Evaluate shoreline, outer reef, and near-coastal fishing capture methods and fishery potential
- Perform standardized qualitative in-water surveys
- Organize outreach and education materials for WIA residents and visitors.

To establish a reliable baseline, two different general survey techniques will be employed. The first involves several standardized capture techniques commonly used on Wake Atoll, including cast nets in shallow shoreline habitats and several kinds of hook and line capture techniques on nearshore and offshore habitats. These will be performed in a standardized way to allow quantitative analysis of catch-per-unit-effort (CPUE) values for target species as a baseline for continued monitoring of these species in the future. The second technique involves standardized quantitative in-water

surveys performed by divers to measure the abundance of both target species and non-target species, including a more general assessment of species assemblages across a range of exploited coral-reef habitats. Establishing this more general baseline of reef-fish diversity and abundance will be important for comparison with CPUE data, for monitoring species typically targeted by spearfishing, and for a broader baseline assessment needed for longer-term monitoring of reef health and the impact fishing pressure may have on the reef ecosystems at Wake Atoll. Methods used to accomplish this task involving fish capture (and release) were selected and will be implemented with the intention of catch and release of specimens and in accordance with American Fisheries Council guidelines.

To complement the collection survey techniques, in-water surveys will be conducted using extended-ranging diving gear (closed-circuit rebreathers), to allow safe access to greater depths, longer dive durations for maximal survey data per day, and accurate and verifiable observations documented using video techniques. A general overview of survey methods is described below.

4.2 Nearshore Fishery Evaluation

4.2.1 Gear Types

1. Cast Net (commonly used on Wake Atoll for baitfish [typically mullet] collection when fishing for target species)
2. Hook and Line Gear types- spinning gear and saltwater fly fishing gear
 - a. Live bait (troll and cast) – medium spinning gear and casting gear
 - b. Baited hook – heavy spinning gear
 - c. Lures – ultra lite spinning gear and saltwater fly fishing gear
 - d. Jigs – light spinning gear and saltwater fly fishing gear
3. Diver Transects (used to complement and ground-truth the catch-and-release methods for target species, and to sample non-target species and species taken by spearfishing).

4.2.2 Near-shore Survey Locations

At a minimum eight near-shore fishing locations will be surveyed. Several of these locations were previously identified in Table 5-8 of the INRMP as common fishing locations. The first five of these locations were previously surveyed in 2012 as part of the brodifacoum (rat bait) fish tissue bioaccumulation study because they were well known areas where recreational fishing (and fishing areas where species were collected for consumption). Near-shore fishing survey locations are presented below and in Figure 1:

- Lagoon shoreline area west of Ioki Beach House
- Lagoon area west of Water Plant (outside of the now prohibited for recreation)
- Lagoon area offshore the AF beach house

- Lagoon area north of Nitro Rock on Wilkes Island, and
- Lagoon south of Peal Island

Other frequented fishing areas that will be surveyed include:

- Harbor area (entire harbor) and channel
- Shallow channel between Peale Island from Wake Island
- Area on outside of reef near solid waste management area

Additional surveys may be conducted on the southern side of the island, as this is typically the side that is accessed by recreational divers (shore dives) and shoreline fishers targeting the outer reef shoreline. Other outer reef locations may be surveyed depending on general weather and bathymetric conditions. Fishing surveys will also be performed at night at a selected subset from the above list. A limited number of visual surveys will be conducted within reef areas prohibited to fishing as depicted in Figure 1 of the Wake Island Operating Instructions Appendix B.

4.2.3 Near-Shore Fishery Assessment Methods

4.2.3.1 Cast Net

The cast net is a commonly used gear type used on Wake Atoll for the collection of bait fish used for the pursuit of target predators, including the target species such as Bluefin trevally *Caranax melampygus* and Blacktail snapper *Lujanus fulvus*. Typically mullet *Mugilidae sp.* are targeted with cast net for use as a bait fish. However, other species are sometimes targeted for consumption, such as Flagtail *Kuhlia sp.* This study will survey the abundance of nearshore schools of species targeted by cast net fishers. Typically, large schools of the targeted species congregate near the areas where residents have set up small shoreline rest areas where they practice occasional feeding of fish with table scraps. In the mornings and evenings, large schools of small fish congregate on the leeward shorelines of the lagoon. Visual estimation and some cast net retrieval is planned for this assessment. A visual estimate of the quantity of fish comprising schools of baitfish is difficult and more emphasis will be placed on the type of species, the number of fish schools observed, and their location along the shoreline. Some of the fish caught in this portion of the study will be used in the hook and line evaluation portion of this project as baitfish.

4.2.3.2 Hook and Line

This is the most common form of recreational fishing on Wake Atoll. The general approach for the health of marine resource will be consistent with standard techniques currently used by USFWS, NMFS, and other federal agencies. The standard comparison is catch per unit effort (CPUE). For the purposes of our study, three fishers will be employed and a factor will be applied if a fisher uses more than one pole (example bait casters and trollers often use multiple poles and the number of poles often exceeds the number of fishers. For each location, the number and size of fish (for

each species) collected per gear type will be recorded and compared with the time spent fishing each gear type. This is consistent with the data required to be collected by recreational fishermen in the Wake Island Operating Guidelines. This may also include trolling within the lagoon on small fishing kayaks that are available through the Moral Welfare and Recreation program.

4.2.3.3 Diver Transects

To establish a proper baseline of fishes at Wake Atoll, we will complement the Cast Net and Hook and Line surveys with diver-based visual and video transects. The quantitative transects will be conducted following methods used by NOAA for previous surveys at Wake Atoll, and in the Northwestern Hawaiian Islands (including belt transects and Stationary Point Count (SPC) methods. Additional video-based surveys used during BPBM surveys throughout the Pacific will also be used.

These survey methods will allow both quantitative and qualitative assessments of the populations of both target and identified non-target species, including both the species likely to be captured with Hook and Line (e.g., *Caranax melampygus*, Lutjanidae, Mullidae) as well as species more apt to be targeted by spearfishing (e.g., *Cheilinus undulatus*, *Bolbometopon muricatum*, and other species). Including these surveys alongside the capture techniques will corroborate the results and expand the scope of documented species.

Moreover, the diver-based surveys will allow a more complete quantitative assessment and qualitative inventory of non-target species at Wake Atoll, which are important for long-term monitoring of reef health, as well as secondary impacts from recreational fishing activities of targeted and bycatch species. Diver-based surveys will include a combination of transects and stations to observe the abundance of each species, their size, and sex if possible (e.g. sex-specific color variations in parrot fish), depth distributions, and other relevant parameters.

To complement the collection survey techniques, in-water surveys will be conducted using extended-ranging diving gear (closed-circuit rebreathers), to allow safe access to greater depths, longer dive durations for maximal survey data per day, and accurate and verifiable observations documented using video techniques.

The southern side of the island is typically the most frequently accessed coastline by recreational divers (shore dives) and shoreline due to wind direction predominantly from the northeast. A minimum of twelve transects at six different station locations (two transects per location) will be conducted on the southwestern side of the atoll for fish counts and habitat assessments. Additionally, four transects at two different station locations (two transects per location) will be conducted on the northeastern side of the atoll, if weather permits. These eight priority station locations are indicated in Figure 2. If weather conditions prevent diving on the northwestern side of the atoll during our two-week survey visit, these four transects will be conducted at two additional locations on the southwestern side of the atoll. Additional transects at additional locations around the atoll will be conducted if time and weather conditions allow. Likely alternate station

locations are also indicated in Figure 2. Most station locations will be in areas where fishing activity is known to occur, but some will be selected in areas with little or no fishing activity occurs, to serve as a basis for comparison in assessing changes due to fishing pressure as opposed to changes due to other factors not associated with fishing activities.

Transects will be conducted at two different depths at each location, one in the range of 10–20 m, and the other in the range of 20–30 m. Additional observations and qualitative surveys at other depths will also be conducted and video-documented. The habitat surrounding Wake Atoll, with shallow fringing reefs and steep outer drop-offs, allows for easy comparison of comparable habitats in different depth zones. Every effort will be made to select transect paths with similar habitat to allow for cross-transect comparison of results. Observed habitats for each transect will be recorded on video, and described and characterized using terms consistent with previous NOAA surveys.

A team of three fisheries scientists, Dr. Richard Pyle, Brian Greene, and Scott Moncrief, will use snorkel and scuba diving gear to collect information on the habitat and biological communities on the seaward reefs and lagoon at Wake Atoll. These methods are designed to be complementary to the data collection procedures implemented by the USFWS during their coral and reef survey performed in 2016 to provide consistency in assessment methods and future statistical analysis (USFWS, 2016).

The survey team will be equipped with digital cameras, dive watches, floated GPS units, and datasheets attached to a clipboard to record data. The time on the digital camera will be synchronized with the GPS units by photographing the time of the GPS unit before entering the water. In addition, the time displayed on the dive watch will be photographed and the difference between the dive watch and GPS unit will be recorded on the datasheet. The team will be familiar with the proposed project area and have pre-determined starting points and areas for the initial survey.

A survey transect will consist of the team collecting habitat and target species information as described below along a swim path while towing a floated GPS unit. The floated GPS unit will always be maintained/aligned near the team to minimize the spatial error between the biologists and GPS. All survey transects will be marked by a starting waypoint and an ending waypoint. GPS units will be set to the local time and set to record a track log automatically at 5-second intervals.

The biologists on the survey team will consist of a coral surveyor and fishery target species surveyor. Both biologists will collect data on observed habitat zones, percent cover. The visual observation area that will be qualitatively evaluated will be estimated by each biologist and recorded in meters (m). The estimation distance will be influenced by water clarity, rugosity of habitat, complexity of habitat, water depth, and other environmental conditions that limit visual distance. One biologist will be assigned as the navigator; this person will follow a pre-determined compass bearing, habitat boundary or other criteria that may have determined the survey transect path. Each scientist will carry an underwater camera to document species and habitat types observed.

4.2.4 Offshore Fishery Evaluation

4.2.4.1 Offshore Gear Types

1. Hook and Line Method - Offshore Trolling Gear
 - a. Live bait (trolling)
 - b. Lures
2. Hook and Line Method - Jigs with medium action offshore trolling gear

4.2.4.2 Offshore Survey Locations

Depending on the weather, sampling will occur either around the entire circumference of Wake Atoll or limited to the leeward (southwestern) side of the island if conditions are severe. The leeward side of the island is typically the Southern coastline of Wake Atoll. This portion of the study will be conducted with the vessel and USCG licensed operator provided by CFSI. Surveys will be conducted well outside the outer reef area prohibited depicted in Figure 2 in Appendix B of the Wake Island Operating Instructions.

4.2.4.3 Offshore Fishery Assessment Method

Up to four crewmembers will be aboard the vessel (including Operator/Captain) and will target early morning hours. Various gear types mentioned above will be used on different fishing days. A CPUE approach per species caught and total mass harvested will be recorded. Catch and release of the fish will be the primary method of sampling and care will be made to use hook removal equipment that does not require the fish to be landed. In these cases, biometric ratio indexes will be used to determine the mass of the fish caught and released. For smaller pelagic fish, such as Skipjack Tuna *Katsuwonus pelamis* and juvenile Yellowfin Tuna *Thunnus albacares*, removal from the water may be required and a scale with a cradle-like container will be used to obtain the mass of the fish prior to returning it to the ocean.

4.2.3 Fish Handling Care

Non-lethal fish handling techniques will be used during the study to ensure that unintentional mortality of fish specimens does not occur. Handling techniques that minimize disturbing the protective mucilaginous layer on the fish to reduce the risk of infection and disease. Minor scratches and wounds as a result of the fish thrashing about when landed will also be prevented and fighting time during angling minimized to avoid systemic lactic acid build-up and stress.

The methods and analyses selected and employed will be chosen to enable 611th CES the ability to compare data in future years against the data collected through this baseline survey. The data generated from this effort will be used to evaluate whether target or non-target species are experiencing a population decline or other form of

impact due to fishing or other stressors. All field survey work will be accomplished during a single two-week visit to Wake.

5. OUTREACH AND EDUCATION

5.1 Educational Video

BPBM will prepare Outreach and Education training materials that will include a short video and/or slide presentation providing an overview of the project as well as the components of the Wake Island Operating Plan. In addition the conservation measures, gear type requirements (e.g., barbless hooks), rules and open fishing areas, emphasis will be placed on the value of the data provided by the recreational fish population is important for the continued health of the fishery and its overall sustainability. Instruction will also be provided as to where and how to complete the FDS forms and where to obtain them and submit them. These meeting materials will be developed in close consultation with the PACAF 611 Natural Resource team, and deliverable will be provided in accordance with the schedule stated in the SOW (Task 3). The video will be presented initially at the public outreach reception described in Section 5.2 below. An outline of the proposed video is presented in Appendix C.

5.2 Public Outreach Event

While on the island, the BPBM team will conduct an all-hands invitational outreach event with the Island community. The event will be scheduled in advance to coincide with a day where the largest number of Wake Atoll residents are available to attend voluntarily (Saturday or Sunday) and will not conflict with scheduled work hours. Currently, the proposed location for the Outreach and Education event is the Drifters Bar outdoor covered lanai area. This facility is popular with the island residents and has enough required space to hold the number of residents expected to attend this event (estimated at approximately 75 persons). Prior to arriving on the island, BPBM will coordinate a date and time for such event with the islands Commander and (Base Operations Support) BOS contractor site manager.

The outreach event will be catered towards those who intend to fish while living on the atoll, with an emphasis on reef and lagoon fishing practices. The BPBM team understands that mandatory attendance during weekends is not something the government can enforce BOS contractors to perform, so voluntary language will be utilized in all advertisements for this event. This outreach event will include an instruction to attendees to perform a careful release, fish identification, safe hook removal, measuring techniques, how to populate the PRSC's recreational fishing survey forms, and a review of common scientific fish terms which appear on the USAF/PRSC Wake Island Fishing Log. Prior to completion of the outreach event, BPBM will log the names of all participants and depict such name attendance sheet within the draft project report. BPBM will provide photo documentation of the outreach event and include it in

the Draft Project Report. Presentation material utilized during the event and the efficacy of such training will be discussed in the Draft Project Report.

In support of the outreach event, the BPBM team will procure and give away hats, long sleeve wicker UV shirts, and letters of educational certification recording attendance to those who attend the volunteer outreach event. Enough items will be provided to give one of each item to all of the estimated of approximately 75 attendees (with an allowance for additional give away materials to handle a higher than expected attendance). A draft outreach event program depicting the outreach events composition, materials to be presented, instructors, and a complete schedule is presented in Appendix D. The draft outreach event program will satisfy “Deliverable B”, while the final outreach event program and associated populated comment matrix, will satisfy “Deliverable B1, and B2” respectively of the SOW. The 611th CES will have 28 days to review and provide comments on the draft outreach event outline. BPBM will submit a final outreach event program to the 611th CES within 14 calendar days of receiving comments from the government along with a populated and completed comment response matrix addressing each government comment.

5.3 Kiosk Development

In accordance with Task 4 of the SOW, BPBM will develop, design and construct an education kiosk to serve as a pick-up and drop-off point for USAF/PRSC – Wake Atoll Fishing Log forms completed by fishermen at Wake Atoll. All text associated with the kiosk will be presented in both Thai and English, and all materials depicted in the kiosk will cater to both languages. For the purposes of the draft materials, translation from English to Thai will be performed at the draft final stage. BPBM will ensure that the INRMP Wake Island Operating Guidance document (13 April 2017) is available at the kiosk and is presented in both Thai and English.

The kiosk will also include at least 300 blank copies of the USAF/PRSC – Wake Atoll Fishing Log form both English and Thai languages (300 each). The kiosk will include a drop box for submitting completed forms, and will also incorporate a video monitor with looping visual presentation (same as developed as described in Section 3.3.1), presented in both Thai and English. The kiosk video content will focus on applicable laws affecting the fishing program, the 13 April 2017 INRMP Fishing Guidance document and associated USAF/PRSC – Wake Atoll Fishing Log, and photos of commonly encountered species. A Draft Kiosk Plan and drawings are presented in Appendix E.

The draft kiosk plan and drawings fulfill “Deliverable C” of the SOW, while the final kiosk plan with design drawings and the separate populated comment matrix will fulfill “Deliverable C1” and “Deliverable C2” of the SOW. The draft and final video footage intended for usage at the kiosk will be submitted on DVD to the government using the schedule in Section 6 of the SOW for the draft and final report submission timelines. The draft video footage fulfills “Deliverable D” of the SOW, while the final video footage

and populated comment matrix defined will fulfill “Deliverable D1” and “Deliverable D2,” respectively.

6. PROJECT REPORT

All information gathered during the baseline surveys, including catch data, transect data, images and video will be analyzed to provide a quantitative assessment of the population status and condition of target and non-target fish species, as well as an initial biodiversity survey of the fishes inhabiting Wake Atoll. BPBM will incorporate historical data and reports from previous research at Wake and similar atolls, as documented in peer-reviewed literature in order to validate methods and analysis selected for the project. These analyses will integrate comparisons to other tropical locations (e.g., Northwestern Hawaiian Islands) so as to give the reader an understanding as to how the data collected at Wake Atoll compares with similar data collected elsewhere on similar or the same species. The draft reports will follow the *Journal of Wildlife Management* format for article submissions. An Executive Summary will also be created and submitted as part of the draft and final reports. Recommendations for future teams who will sample fish populations in future years shall be included in the draft report. GIS-generated maps will be included in the report depicting locations of sampling. Level of effort will be quantified using time (hours) and other parameters so as to give the reader an understanding of what level of effort yielding the sample sizes depicted in the report. The methods section of the draft report will grant a reader the ability to track how data were collected in an unbiased fashion.

The draft project report will be submitted no later than 14 months after the award date. The installation shall be granted 14 calendar days to provide the BPBM with comments on their respective draft project report. The draft project report will fulfill “Deliverable E”.

BPBM will incorporate comments provided by the 611th CES into the draft report within 14 calendar days of receipt of 611th CES comment and return a final project report to the 611th CES, alongside a response to comment matrix displaying how each comment was addressed in the Final Project Report. The Project Report shall be defined as final, once accepted by the 611th CES. The final report shall be deemed “Deliverable E1”, while the populated comment matrix deemed “Deliverable E2”.

7. REFERENCES

- Brainard, R., J. Asher, J. Gove, J. Helyer, J. Kenyon, F. Mancini, J. Miller, S. Myhre, M. Nadon, J. Rooney, R. Schroeder, E. Smith, B. Vargas-Angel, S. Vogt, and P. Vroom. 2008. Coral reef ecosystem monitoring report for American Samoa: 2000-2006. Pacific Islands Fisheries Science Center Special Publication, SP-08 002. Honolulu: Pacific Islands Fisheries Science Center.
- EA Engineering, Science and Technology, Inc. (EA). 2013. Intertidal Benthic Community Structure and Recolonization after Removal of the Peacock Point (Wake Island Air Field) Burn Pile. Draft Site OT10 Intertidal Survey Report, Wake Island Air Field, Wake Atoll.
- CH2M HILL. 2010. Remedial Investigation/Feasibility Study Report for the Site OT10 (Peacock Point Burn Area No. 1), Wake Island Air Field, Wake Atoll, Final. April 2010.
- Kenyon J.C., V. Bonito and C. B. Wilkinson. 2013. Characterization of Coral Communities at Wake Atoll in the Remote Central Pacific Ocean. Atoll Research Bulletin No. 600. Smithsonian Institution Scholarly.
- Levenson, J. B. 2008. Integrated natural resources management plan for Wake Atoll. Hawaii: 15th Civil Engineering Squadron, E. P. E., Hickam Air Force Base
- National Oceanographic and Atmospheric Administration (NOAA). 2015. The Search for Juvenile Bumphead Parrotfish (*Bolbometopon muricatum*) in the Lagoon at Wake Island. Administrative Report H-15-02. Prepared by: M. Sundberg, D. Kobayashi, S. Kahng, S. Karl and J. Zamzow. Pacific Islands Fisheries Science Center. February.
- United States Air Force (USAF). 2002. Final Risk Evaluation of Chemical Levels in Fish Tissue Wake Island Air Field, Wake Atoll. Prepared for: Air Force Center for Environmental Excellence Environmental Restoration Division (AFCEE/ERD), Brooks Air Force Base, Texas and 36 CES/CEVR, Andersen Air Force Base, Guam. Prepared by: URS Group, Inc. 30 September.
- United States Air Force (USAF). 2012. Wake Island Lagoon Marine Organism Testing for Brodifacoum. Memorandum of Record. 611 CES/CEAN. 16 July.
- United States Fish and Wildlife Service Pacific Islands Fish and Wildlife Office. 2016. Marine and Shallow Coral Reef Survey Work Plan. Wake Atoll, Pacific Ocean. 07 July.

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APPENDIX A PROJECT SCHEDULE

Draft Wake Atoll Baseline Fishery Surveys Work Plan

Overall Project Schedule

Bernice Pauahi Bishop Museum

Contract No. W912UM17P0017

Activities	Duration	Start	Finish	Aug												Oct												Nov												Dec												Jan												Feb												Mar												Apr												May												Jun												Jul												Aug												Sep												Oct												Nov											
				28	2	9	16	23	30	6	13	20	27	4	11	18	25	1	8	15	22	29	5	12	19	26	2	9	16	23	30	6	13	20	27	4	11	18	25	1	8	15	22	29	5	12	19	26	2	9	16	23	30	6	13	20	27	4	11	18	25	1	8	15	22	29	5	12	19	26																																																																																																																	
1. Kick-off Meeting	1	Wed 10/11/17	#####																													● 11 Oct																																																																																																																																																							
2. Task 1: Fisheries Work Plan	154	Thu 8/31/17	Wed 1/31/18																																																																																																																																																																																				
1) Prepare Draft	104	Mon 10/23/17	Sat 2/3/18																																																																																																																																																																																				
2) Government Review of Draft	30	Sun 2/4/18	Mon 3/5/18																																																																																																																																																																																				
3) Respond to Government Comments	14	Tue 3/6/18	Mon 3/19/18																																																																																																																																																																																				
4) Submit Final	7	Tue 3/20/18	Mon 3/26/18																																																																																																																																																																																				
3. Task 2: Fisheries Surveys	21	Mon 8/27/18	Sun 9/16/18																																																																																																																																																																																				
1) Mobilize Equipment for Transport	7	Tue 8/28/18	Mon 9/3/18																																																																																																																																																																																				
2) Conduct Near Shore Survey	7	Tue 9/4/18	Mon 9/10/18																																																																																																																																																																																				
3) Conduct Offshore Survey	7	Tue 9/11/18	Mon 9/17/18																																																																																																																																																																																				
4. Task 3: Outreach and Education	270	Mon 12/4/17	Thu 8/30/18																																																																																																																																																																																				
1) Prepare Draft	60	Mon 12/4/17	Thu 2/1/18																																																																																																																																																																																				
2) Government Review of Draft	30	Fri 2/2/18	Sat 3/3/18																																																																																																																																																																																				
3) Respond to Government Comments	14	Sun 3/4/18	Sat 3/17/18																																																																																																																																																																																				
4) Submit Final	7	Sun 3/18/18	Sat 3/24/18																																																																																																																																																																																				
5) Order Meeting Handout Materials	1	Sun 3/4/18	Sun 3/4/18																																																																																																																																																																																				
6) Conduct Meeting	1	Wed 9/5/18	Wed 9/5/18																																																																																																																																																																																				
5. Task 4A: Kiosk	270	Mon 12/4/17	Thu 8/30/18																																																																																																																																																																																				
1) Prepare Draft	60	Mon 12/4/17	Thu 2/1/18																																																																																																																																																																																				
2) Government Review of Draft	30	Fri 2/2/18	Sat 3/3/18																																																																																																																																																																																				
3) Respond to Government Comments	14	Sun 3/4/18	Sat 3/17/18																																																																																																																																																																																				
4) Submit Final Design	7	Sun 3/18/18	Sat 3/24/18																																																																																																																																																																																				
5) Build Kiosk/Test/ Disassemble	30	Sun 3/4/18	Mon 4/2/18																																																																																																																																																																																				
6) Install Kiosk on Wake Atoll	1	Tue 9/4/18	Tue 9/4/18																																																																																																																																																																																				
6. Task 4B: Educational Video	77	Mon 5/7/18	Sun 7/22/18																																																																																																																																																																																				
1) Prepare Draft	14	Tue 5/8/18	Mon 5/21/18																																																																																																																																																																																				
2) Government Review of Draft	30	Tue 5/22/18	Wed 6/20/18																																																																																																																																																																																				
3) Respond to Government Comments	14	Thu 6/21/18	Wed 7/4/18																																																																																																																																																																																				
4) Submit Final Video	7	Thu 7/5/18	Wed 7/11/18																																																																																																																																																																																				
7. Task 5 & 6: Draft and Final Project Report	70	Mon 9/17/18	Sun 11/25/18																																																																																																																																																																																				
1) Prepare Draft	21	Tue 9/18/18	Mon 10/8/18																																																																																																																																																																																				
2) Government Review of Draft	30	Tue 10/9/18	Wed 11/7/18																																																																																																																																																																																				
3) Respond to Government Comments	14	Thu 11/8/18	#####																																																																																																																																																																																				
4) Submit Final Report	7	Thu 11/22/18	#####																																																																																																																																																																																				
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Daily Schedule During Two-Week Expedition at Wake Atoll

Daily Schedule - Baseline Fishery Surveys Wake Island Atoll														
	Week 1							Week 2						
Date	8/31/2018	9/1/2018	9/2/2018	9/3/2018	9/4/2018	9/5/2018	9/6/2018	9/7/2018	9/8/2018	9/9/2018	9/10/2018	9/11/2018	9/12/2018	9/13/2018
Time	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday
5:00:00 AM		Gear Set-up	Near Shore - Bait Collection	Near Shore - Bait Collection	Gear Set-up	Gear Set-up	Gear Set-up	Gear Set-up	Gear Set-up	Near Shore - Bait Collection	Near Shore - Bait Collection	Gear Set-up	Gear Set-up	
6:00:00 AM	Flight from Hickam (Depart Thursday 30 August at 10:00 AM local time and arrive at Wake Island Airfield on 31 August at 10:30 AM local time)	Breakfast			Breakfast	Breakfast	Breakfast	Breakfast	Breakfast			Breakfast	Breakfast	Breakfast
7:00:00 AM		Near Shore - Bait Survey												
8:00:00 AM						Educational Outreach - Set up Kiosk/Prep for Event								Head to Airport
9:00:00 AM			Offshore Survey - Troll Gear (Vessel)	Offshore Survey - Troll Gear (Vessel)	Near Shore Fishing - Lagoon		Near Shore - Visual Survey (Vessel)	Offshore Survey - Troll Gear (Vessel)	Near Shore - Visual Survey (Vessel)	Offshore Survey - Troll Gear (Vessel)	Offshore Survey - Troll Gear (Vessel)	Near Shore Fishing - Lagoon	Near Shore Fishing - Lagoon	
10:00:00 AM		Near Shore Fishing - Lagoon												
11:00:00 AM						Gear Set-up								
12:00:00 PM	Billeting	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Flight from Hickam AMC (Depart 9:30 AM local time and arrive Hickam at 16:00 pm local time)
1:00:00 PM		Gear Set-up	Gear Set-up	Gear Set-up	Work up Data	Near Shore - Visual Survey (Vessel)	Gear Set-up	Work up Data	Work up Data	Gear Set-up	Gear Set-up	Work up Data	Out Brief with Commander	
2:00:00 PM	In Brief with Commander												Demobilize - Pack/Settle Billeting	
3:00:00 PM	Check out USAF/CFS Vessel	Near Shore Fishing - Lagoon	Near Shore - Visual Survey (Vessel)	Near Shore - Visual Survey (Vessel)	Near Shore Fishing - Lagoon		Near Shore - Visual Survey (Vessel)	Offshore Survey - Troll Gear (Vessel)	Educational Outreach - Public Outreach at Drifters	Near Shore - Visual Survey (Vessel)	Near Shore - Visual Survey (Vessel)	Near Shore Fishing - Lagoon		
4:00:00 PM	Set-up Dive Supply Station												Public Outreach - Adjust Video at Airport Kiosk	
5:00:00 PM	Orientation - Survey Locations					Offshore Survey - Troll Gear (Vessel)								
6:00:00 PM	Dinner	Dinner	Dinner	Dinner	Dinner		Dinner	Dinner		Dinner	Dinner	Dinner	Dinner	
7:00:00 PM		Gear Set-up	Near Shore Survey - Night	Gear Set-up	Near Shore Survey - Night		Near Shore Survey - Night	Gear Set-up		Gear Set-up	Work up Data	Near Shore Survey - Night	Demobilize - Pack/Settle Billeting	
8:00:00 PM	Near Shore Survey - Night													
9:00:00 PM														



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APPENDIX B FIGURES

Draft Wake Atoll Baseline Fishery Surveys Work Plan

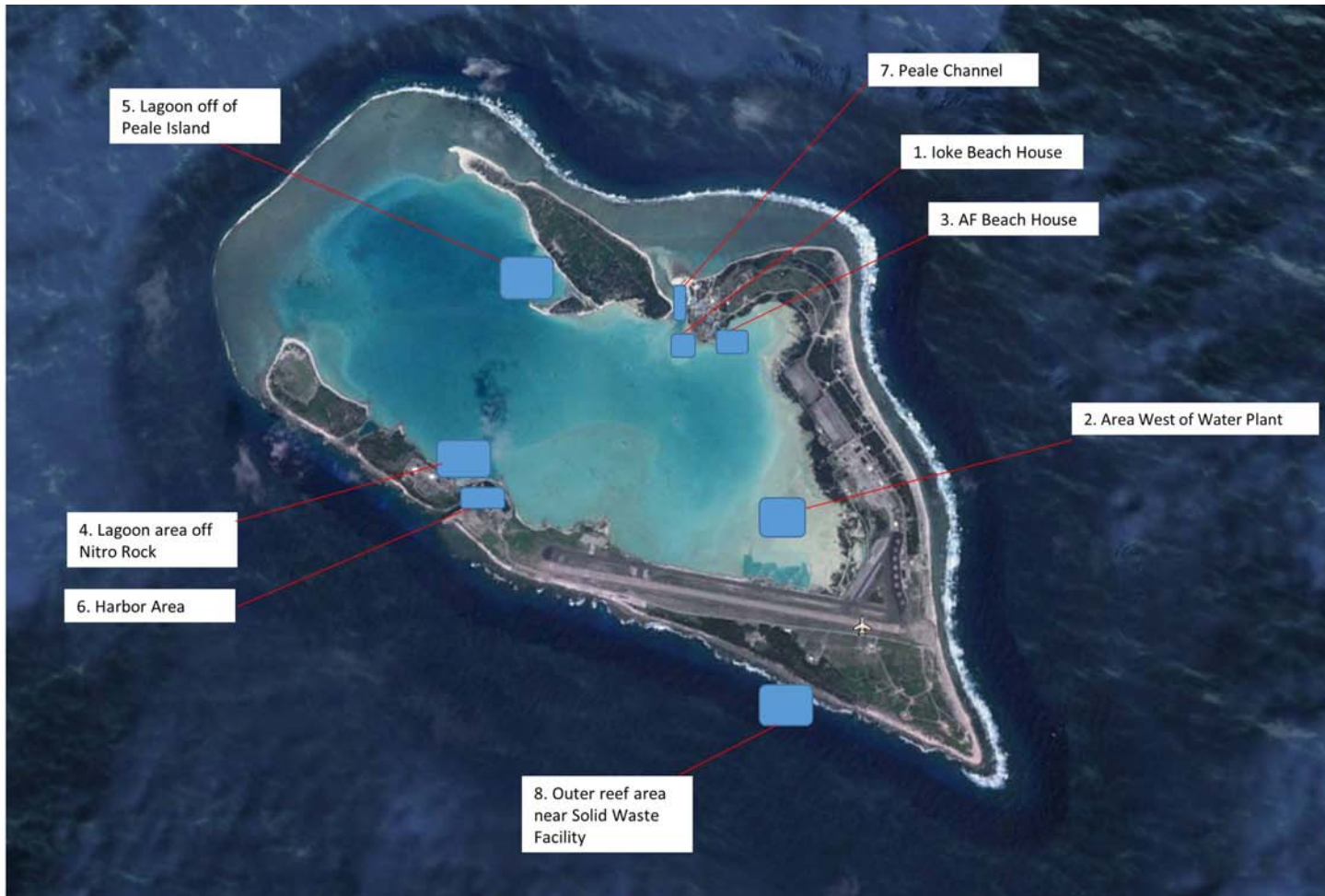


Figure 1. Map of Wake Atoll showing proposed near-shore fishing survey locations.

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Figure 2. Proposed priority (stars) and alternate (circles) dive transect station locations.



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APPENDIX C EDUCATIONAL VIDEO OUTLINE

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Task	Narrative Description	Shot Description	Duration	Notes
Opening scene	N/A	Three underwater videos of schools of fish (trevally, goatfish, and bonefish) swimming aggressively. 2-3 seconds (s) each video. No fades.	6s	Hawaiian music (relaxing) playing in the background with sounds FX of fish swimming intermingled.
Opening scene	N/A	Video of boat with people hooking up and fighting fish. No fades	5s	Hawaiian music playing in the background.
Opening scene	N/A	Video of people landing fish onto the boat. No fade	3s	Hawaiian music playing in the background.
Opening scene	N/A	Close up video of fish landed with a barbless hook in mouth and person taking the hook out. Cut to picture of landed fish with fisher. Fade to video of fisher throwing fish into cooler or releasing fish back to the ocean.	10s	Hawaiian music playing in the background.
Title	N/A	“Wake Island Fishery Management” title appears on screen with pan of an aerial photo of wake atoll in the background. Fades out to black for 3s.	7s	Hawaiian music fades out with fade out of Wake Atoll aerial photo.
Introduction	Explain the fish species diversity in Wake Island waters and protected species.	Pictures appear on the screen of different targeted fish species and protected fish species (bonefish, trevally, goatfish, snapper, bumphead parrotfish, and humphead wrasse). Fade in photo of each fish for 1s, Pan each photo for 5s and fade out for 1s.	25s	Protected species photos clearly labeled “Protected”.
Intro/Discussion	Explain the purpose and requirements of new fishing regulations.	Videos of spawning fish, baitfish, and adult fish.	15s	Narrative
Discussion	Explain why the fishing regulations affect the viewer.	Videos of overfishing, fishery closed signage (No Fishing).	15s	Narrative

Draft Wake Atoll Baseline Fishery Surveys Work Plan

Task	Narrative Description	Shot Description	Duration	Notes
Discussion	Explain fisher's log.	Cut to pan of 3 photos of fisher's logs.	10s	
Discussion	Explain how to fill out fisher's logs and required data.	Fade into videos of Fisher catching fish and filling out the fisher's log with required data.	30s	Narrative
Discussion	Explain proper collection of data for fisher's log.	Fade into a video of proper species identification, determining fork length measurement, determine catch or release, and proper release techniques.	45s	Narrative
Discussion	Explain where to get the fisher's log forms.	Cut to picture of fisher's log location for 5s. Fade to video of Fisher picking up log form.	10s	Narrative
Discussion	Explain how to submit the fisher's log.	Video of fisher taking fisher's log to proper drop box for reporting.	10s	Hawaiian music (cheerful and upbeat) fades in.
Conclusion	Encourage viewer to protect our environment, properly log fish, and to hopefully catch fish.	Fade to videos of people enjoying fishing at Wake Atoll.	10s	Hawaiian music in the background.
Conclusion	Reiterate process of new fishing regulations.	Cut to 5 photos of Wake Atoll including photos of people fishing (boat, shore, and free dive). 2s each photo.	10s	Hawaiian music in the background.
Outro	Thank the viewer.	Fade into videos of the ocean.	10s	Hawaiian music in the background with natural sounds of ocean intermingled.
End	N/A	Fade to black.	2s	Music fades.
Total Time: 3 minutes, 43 seconds(s)				

APPENDIX D OUTREACH EVENT PROGRAM

Draft - Wake Atoll Fishery Educational Outreach Program

- I. Introduction – Cast to the Audience (Delivered by Richard Pyle) – Estimated 10 minutes
 - a. Wake Atoll's Unique Fish Habitat
 - i. Geography –
 1. One of the most remote northern tropical Pacific atolls
 2. Remoteness and military mission has protected from a vast majority of the fishing pressures that other similar atolls in the world have experienced.
 - ii. History –
 1. Pan American Clipper route and site of the Clipper Hotel in the 1930s
 2. Late 1930's U.S. Military begins to fortify the shoreline defenses in response to colonial and military expansion in Western Pacific.
 3. 1941 Wake is attacked by Japan and occupied until September 4, 1945
 4. Since 1945 Wake has been an important U.S. military installation
 - a. Supports refueling of military aircraft
 - b. Missile Defense Agency testing facility
 - iii. Climate
 1. Semi-tropical climate supports a diverse community of reef species that include many species that are found throughout the Indo-Pacific
 2. Species diversity of vertebrate and invertebrates exceeds that of the Hawaiian Island marine biodiversity
 - iv. Geology
 1. Wake is unique in being an isolated atoll. Many atolls are part of an island chain like those typically found in the Pacific.
 2. Wake is likely one of the oldest atolls in the world (~100 million years) and supports rich populations of marine organisms
 3. Wake Atoll may contain numerous undiscovered marine species some of which may prove to be endemic (i.e., occur nowhere else on Earth).
 - v. Summary
 1. Wake Atoll is an important laboratory to not only study what a pristine coral atoll should look like, but it also may represent a very unique geographic and geologic history.
 - b. Types of marine vorganisms at Wake Atoll
 - c. General information and identification of marine species
 - i. Target species

- ii. Non-target species
 - iii. Protected species
 - 1. Bumphead Uhu
 - 2. Humphead Wrasse
 - 3. Monk Seal
 - 4. Sea Turtle
- II. Discussion (Delivered by Scott Moncrief) – Estimated 10 minutes
- a. Describe types of fishing gear/techniques allowed at Wake Atoll
 - i. Hook and line (most common)
 - 1. Line and sinker
 - 2. Live bait (troll)
 - 3. Baited hooks
 - 4. Lures
 - 5. Jigs (offshore)
 - 6. Barbless hooks
 - ii. Cast net (baitfish, mullet, etc.)
 - iii. Spear fishing (free dive and SCUBA)
 - iv. Prohibited fishing techniques
 - b. Identification of open and closed fishing areas at Wake Atoll
 - c. Explain purpose and goals of new fishing regulations
 - i. Coastal zone management
 - ii. Marine resource management
 - iii. Regulatory agencies for Wake Atoll fisheries
 - 1. List purpose
 - 2. Contact information
 - 3. Reporting of fishing violations and incidents
 - d. Explain requirements of new fishing regulations
 - i. Fisherman Data Sheet/Fishers Log
 - e. Explain who new fishing requirements affect
 - f. Explain the Fisherman Data Sheet/Fishers Log (FDS)
 - i. Where to find FDS (i.e. kiosk or online)
 - ii. How to properly populate the FDS
 - 1. Species Identification (non-target, target, protected)
 - 2. Fork length measurement
 - 3. Determining catch or release
 - 4. Determining gear used
 - 5. Review of common scientific fish terms used in FDS
 - iii. When and how to submit FDS
 - 1. Every two weeks
 - 2. Before leaving Wake Atoll
 - 3. Kiosk drop box

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- g. Explain proper non-lethal fish handling, hook removal (emphasis on barbless hooks), and release techniques
- III. Open Q&A – 20 minutes
- IV. Games and Prizes – 40 minutes
 - a. Hermit Crab Race - 15 minutes total
Objective – Contestants race Hermit crabs over 5-foot long course
 - b. Casting Game - 15 minutes total
Several poles to choose from for contestants (e.g. conventional reel, spinning reel, light tackle, medium tackle, heavy tackle, etc.).
Objective – contestant uses selected fishing set-up to cast a golf ball into a bucket approximately 50 feet away from casting location. Closest to bucket wins. In the event that contestants tie, a second and third round may be held, time permitting.
 - c. Prize giveaway- 10 min
Prizes include hats, long sleeve wicker UV shirts, barbless hooks, fishing line, lures (grubs/jigs/stick baits), etc.
- V. Conclusion/Closing remarks – 5 minutes
 - a. Reiterate purpose of FDS
 - b. Reiterate guidelines to populate FDS
 - c. Thank viewers for attendance
- VI. Letters of Educational Certifications – 10 minutes
- VII. Individual Q&A – time permitting

APPENDIX E KIOSK DESIGN

Draft - Wake Atoll Fisheries Education Kiosk

The Wake Atoll Fisheries Program Kiosk (Kiosk) will provide information about the Wake Atoll Fishers Program components (**Figures K-1, K-2, and K-3**). Particularly, it will include summarized information about the program with respect to some key topics including:

- Fishing methods
 - Permitted gear, etc.
- General Fishing Locations
 - Informational content
 - May also include safety message
- Conservation
 - Catch and Release,
 - Barbless Hooks,
 - Fish Handling Methods, and
 - Areas where consumption is not recommended (e.g., Peacock Point area)
- Data Collection
 - Recording Catch Information, and
 - When and where to turn in survey.

To accomplish this task, the Kiosk will utilize static displays and a video presentation. A conceptual description of the Kiosk is provided below:

Static Display:

The general concept is that static displays will provided brief visual summaries of the basic aspects of the fisheries program and external signage that would communicate the program without the dependency on the video media. Its goal would be to have the Kiosk visitor understand there is a program, invite them to participate in recreational fishing, and communicate their adaption of the program goals is in their best interest as a user of the recreational fishing resource. Most importantly, the goal of the communicated message will be that the viewers should fish within the allowable guidelines and provide accurate reporting of their catch every two weeks.

The Kiosk will be constructed generally of varnished wood, with three equilateral vertical front faces for viewing. Viewed from top, the general shape of the Kiosk is to be a half hexagon, with the three front faces being equal in width (2 feet).

Affixed to the bottom of the Kiosk will be four black rolling and locking casters placed in the four corners of the trapezoid. These casters will aid in the moving and safe placement of the Kiosk and will also allow for maintenance and access to the rear of the Kiosk. The three wooden front faces of the Kiosk will have wooden trim molding (3 inch) at the base to aid in hiding the four rolling and locking casters.

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Cut into the top of the left and right wooden front faces will be a series of electronics ventilation holes (0.5 inch diameter), which will aid in the cooling of the electronic components housed within the Kiosk.

The rear and largest face will provide access to the interior of the Kiosk for maintenance and cleaning via a central access door, which will also allow for access to the utility shelf (**Figure K-2**). The door will be constructed of wood and be fastened with two stainless/brass hinges and secured with a small combination lock. Atop the door and centered on the rear face of the Kiosk will be a small ventilation port (6 inch diameter). Housed within the Kiosk and adjacent to the port opening will be a powered-ventilation fan to aid in the cooling of the internal electronics.

Affixed to the top of the Kiosk will be a large sign consisting of three panels, each panel being approximately 9 inches in height and 2 feet in width, which will contain a clear title, such as “FISH WAKE ATOLL”, informing the viewer of the purpose of the Kiosk.

The front and center face will contain the display/monitor, “push start video button”, one deposit/drop box, and four wooden pamphlet holders. The four wooden pamphlet holders (rectangular wooden boxes (5 inch x 9 inch) affixed to the exterior of the Kiosk) will hold two documents; the catch reporting forms and general fisheries information presented in both Thai and English.

The deposit/drop box will be clearly marked with text. A brief reminder banner would request that the visitor turn in their forms before they depart Wake Atoll. Also affixed near the deposit/drop box will include a reminder banner informing the viewer of how to submit catch reporting forms electronically.

Affixed to the three front faces of the Kiosk will be a series of vinyl printed posters to include graphics and text providing educational information about the Wake Atoll Fisheries Program. These posters will include eye-catching graphics such as pictures of different targeted and protected fish species (e.g., bumphead parrotfish, humphead wrasse, bonefish, bluefin trevally, etc.) and will be predominately located on the left and right front face of the Kiosk.

Video Display:

The general concept of the video display is provided in the outline of the video presentation (Appendix C of the WP). The Kiosk visitor would be visually directed to the “push start video button”. and the “Wake Atoll Fisheries Program Educational Video” would be played. The video would be presented on an Acer 21.5-inch LED HD Monitor (1980x1080 maximum resolution) with DVI and VGA inputs and will be located with the center of the Kiosk’s front middle face and just below the monitor (See **Figure K1**). The “push start video button” will be connected to the Raspberry Pi 3 via a small hole extending through the front middle face of the Kiosk. Housed within the hole is the button electronics and supporting hardware.

Video presentation hardware housed inside of the Kiosk includes the following:

1. Raspberry Pi 3 computer,
2. Acer 21.5-inch LED HD Monitor,
3. Speakers,
4. One HDMI cord,
5. One microSD card,
6. One USB Drive,
7. One “push start video button”, and
8. One surge protector/multi-plug.

With the exception of the 21.5-inch LED HD Monitor, Speakers, and “push start video button”, all hardware will be mounted to the utility shelf located in the central portion of the Kiosk.

The main video electronics include a Raspberry Pi 3, which is a small, compact single-board computer, that will be utilized to play the “Wake Atoll Kiosk Video” via the Monitor. The Raspberry Pi 3 will be housed in a durable case and mounted with screws horizontally to the utility shelf within the Wake Atoll Fishers Kiosk, within close proximity to the “push start video button” located just under the monitor and center of the Kiosk (**Figure K-3**). The Raspberry Pi 3 will be powered via the supplied Raspberry Pi 3 Power Cord which will be connected to the Kiosk surge protector/multi-plug. The “push start video button” will be connected to the Raspberry Pi 3 via connectors protruding from the “push start video button” housing. The Raspberry Pi 3 will be connected to the microSD card containing the Video Looper Program and “push start video button” interface file, and the USB Drive containing the “Wake Atoll Kiosk Video” file. The Raspberry Pi 3 will be connected to one 21.5-inch Monitor via one HDMI cord and applicable connectors

The 21.5-inch Monitor will allow for public viewing of the “Wake Atoll Kiosk Video” and will be interfaced via one HDMI cord to the Raspberry Pi 3, housed on the utility shelf within the Wake Atoll Fishers Kiosk (**Figure K-4**). The Monitor will be held in place and upright by at least two metal brackets attached both top and bottom of the Monitor and to the inside of the Kiosk near the cut-out for the monitor, in the front center face. The 21.5-inch Monitor will be powered via the supplied power cord which will be connected to the Kiosk surge protector/multi-plug.

The HDMI cord will connect the Raspberry Pi 3 and the 21.5-inch Monitor.

The microSD card will contain saved data which will program the Raspberry Pi 3 to loop the “Wake Atoll Kiosk Video” and also interface the “push start video button” and the Raspberry Pi 3. The Video Looper program for the Raspberry Pi 3 is open-source and available for download online.

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The USB Drive will contain saved data to include the “Wake Atoll Kiosk Video” and will be accessed by the Raspberry Pi 3 Video Looper program which will allow for the video to be played on the monitor.

The “push start video button” will allow for the “Wake Atoll Kiosk Video” to be played upon request, and will be located within the center of the Kiosk’s front middle face just below the monitor. Protruding out the back of the “push start video button” and within the Kiosk itself, the electrical wires will be connected and interfaced to the Raspberry Pi 3.

The surge protector/multi-plug will allow for all electronics to be internally powered and electronically protected in the event of electrical surge. Wall outlets within the proposed location of the Kiosk are 110 Volt AC. A heavy gauge three prong extension wire will be connected from wall outlet to Kiosk where it is connected, via a small built-in outlet box, to the base of the Kiosk’s rear face. Connected to the outlet box and within the interior of the Kiosk, the surge protector/multi-plug, of which the plug fascia (5 plug minimum) will be mounted with screws horizontally to the utility shelf.

Construction and testing of the Kiosk will be completed in Honolulu (Oahu) prior to the Kiosk’s arrival to Wake Atoll. Prior to construction, all materials will be sourced. The Kiosk must be designed to be assembled and disassembled easily and repeatedly, therefore metal brackets and screws will be used to attach the Kiosk faces and supporting structures together where applicable. Upon completion of the Kiosk cabinet construction, all software will be uploaded onto applicable memory banks, and all electronic components and will be installed and tested. Verification of a flawless working system is key before shipment, as troubleshooting on Wake Atoll will be difficult at best with such limited resources. Once testing has ensured a flawless system, the Kiosk will be disassembled and packaged for shipment. Each piece of the Kiosk will be carefully packed and prepared for air cargo shipment from Honolulu to Wake Atoll, and be containerized in a protective shipping box. Upon arrival at Wake Atoll, the shipping box will be unpacked and all Kiosk pieces will be inventoried and checked for damage and moved to the Kiosk location where the Kiosk will be reassembled, tested, and housed for permanent use.

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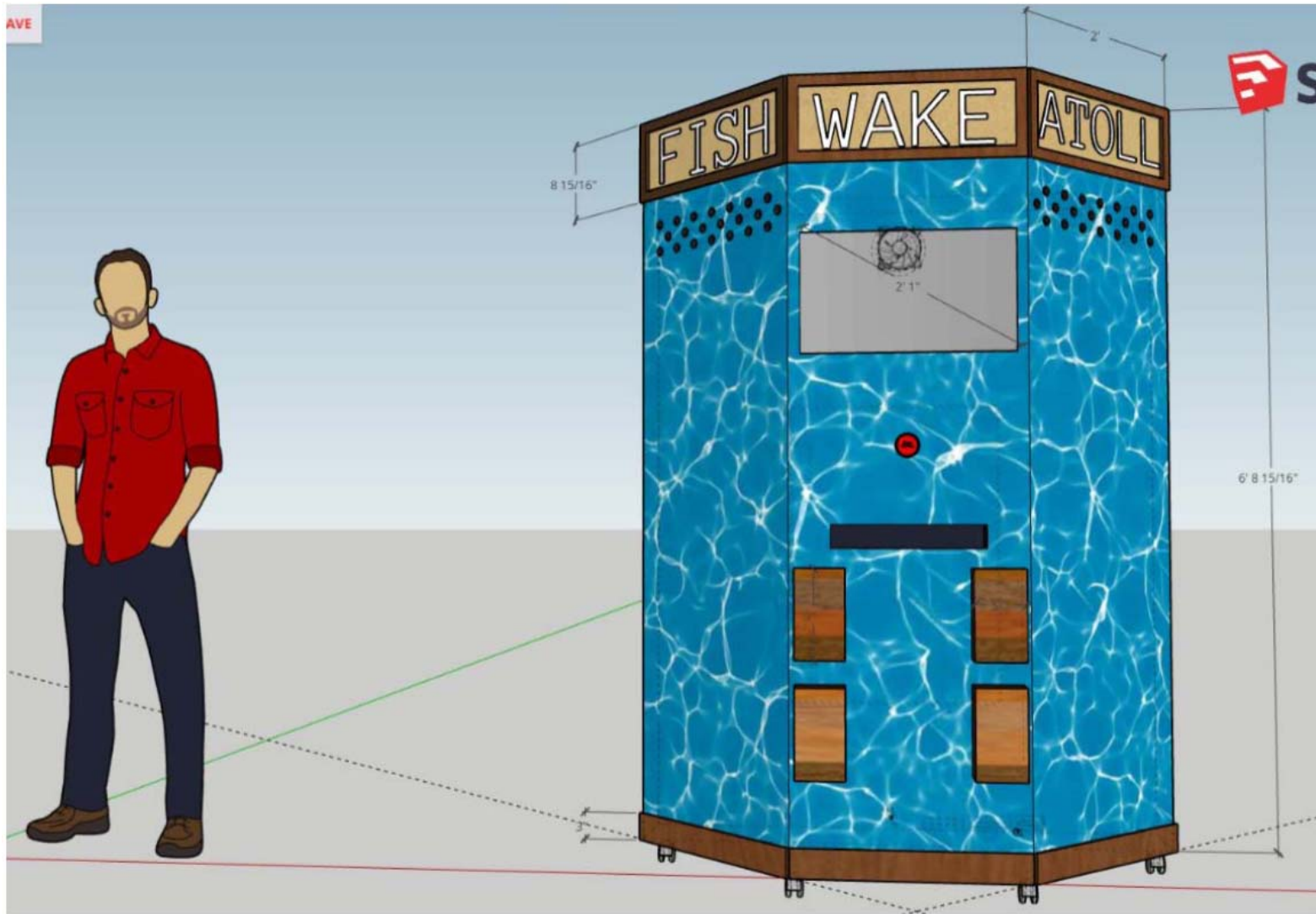


Figure K-1: Front View of Kiosk conceptual design showing display, holders for pamphlets and catch reporting cards, and report deposit slot. Materials will be bi-lingual in English and Thai.

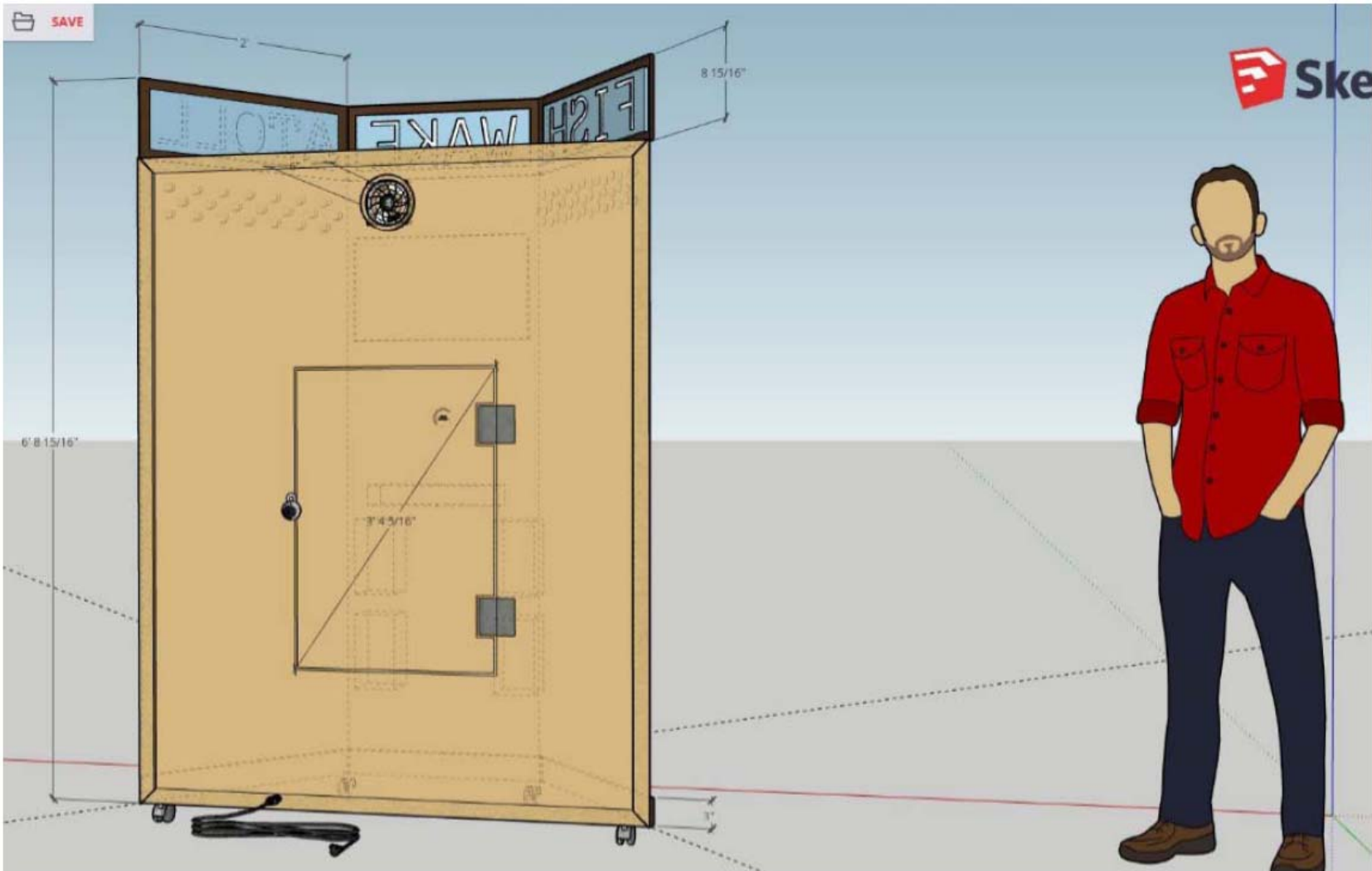


Figure K-2: Rear View of Kiosk conceptual design cover, cabinet door, lock, ventilation fan, and electrical extension chord.

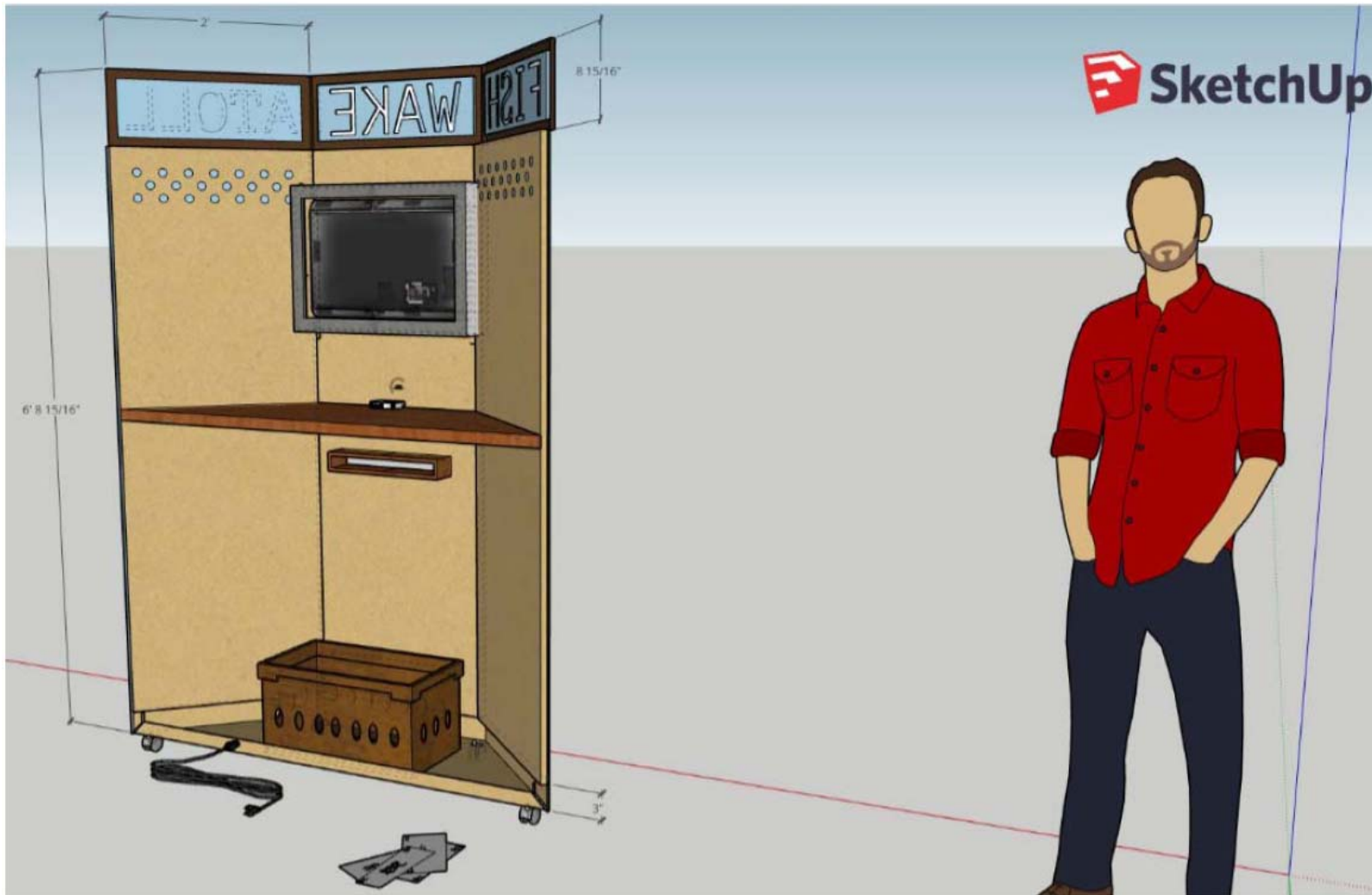


Figure K-3: Conceptual design showing with covers removed to provide a view of the inside of the Kiosk. View shows bin for turned in catch reporting cards, screen mounting detail, and a shelf that would have extra pamphlets and catch reporting cards, and would hold electronic hardware.

Draft Wake Atoll Baseline Fishery Surveys Work Plan



Raspberry Pi 3 set



21.5 inch monitor compatible with the Pi 3



Example of speakers

Figure K-4: Electronic hardware for Kiosk video operation.

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Draft - Wake Atoll Fishery Educational Outreach Program

- I. Introduction – Cast to the Audience (Delivered by Richard Pyle) – Estimated 10 minutes
 - a. Wake Atoll's Unique Fish Habitat
 - i. Geography –
 1. One of the most remote northern tropical Pacific atolls
 2. Remoteness and military mission has protected from a vast majority of the fishing pressures that other similar atolls in the world have experienced.
 - ii. History –
 1. Pan American Clipper route and site of the Clipper Hotel in the 1930s
 2. Late 1930's U.S. Military begins to fortify the shoreline defenses in response to colonial and military expansion in Western Pacific.
 3. 1941 Wake is attacked by Japan and occupied until September 4, 1945
 4. Since 1945 Wake has been an important U.S. military installation
 - a. Supports refueling of military aircraft
 - b. Missile Defense Agency testing facility
 - iii. Climate
 1. Semi-tropical climate supports a diverse community of reef species that include many species that are found throughout the Indo-Pacific
 2. Species diversity of vertebrate and invertebrates exceeds that of the Hawaiian Island marine biodiversity
 - iv. Geology
 1. Wake is unique in being an isolated atoll. Many atolls are part of an island chain like those typically found in the Pacific.
 2. Wake is likely one of the oldest atolls in the world (~100 million years) and supports rich populations of marine organisms
 3. Wake Atoll may contain numerous undiscovered marine species some of which may prove to be endemic (i.e., occur nowhere else on Earth).
 - v. Summary
 1. Wake Atoll is an important laboratory to not only study what a pristine coral atoll should look like, but it also may represent a very unique geographic and geologic history.
 - b. Types of marine organisms at Wake Atoll
 - c. General information and identification of marine species
 - i. Target species
 - ii. Non-target species

- iii. Protected species
 - 1. Bumphead Uhu
 - 2. Humphead Wrasse
 - 3. Monk Seal
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- II. Discussion (Delivered by Scott Moncrief) – Estimated 10 minutes
 - a. Describe types of fishing gear/techniques allowed at Wake Atoll
 - i. Hook and line (most common)
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 - iv. Prohibited fishing techniques
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 - c. Explain purpose and goals of new fishing regulations
 - i. Coastal zone management
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 - 5. Review of common scientific fish terms used in FDS
 - iii. When and how to submit FDS
 - 1. Every two weeks
 - 2. Before leaving Wake Atoll
 - 3. Kiosk drop box
 - g. Explain proper non-lethal fish handling, hook removal (emphasis on barbless hooks), and release techniques

- III. Open Q&A – 20 minutes
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 - a. Hermit Crab Race - 15 minutes total
Objective – Contestants race Hermit crabs over 5-foot long course
 - b. Casting Game - 15 minutes total
Several poles to choose from for contestants (e.g. conventional reel, spinning reel, light tackle, medium tackle, heavy tackle, etc.).
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The 21.5-inch Monitor will allow for public viewing of the “Wake Atoll Kiosk Video” and will be interfaced via one HDMI cord to the Raspberry Pi 3, housed on the utility shelf within the Wake Atoll Fishers Kiosk (**Figure K-4**). The Monitor will be held in place and upright by at least two metal brackets attached both top and bottom of the Monitor and to the inside of the Kiosk near the cut-out for the monitor, in the front center face. The 21.5-inch Monitor will be powered via the supplied power cord which will be connected to the Kiosk surge protector/multi-plug.

The HDMI cord will connect the Raspberry Pi 3 and the 21.5-inch Monitor.

The microSD card will contain saved data which will program the Raspberry Pi 3 to loop the “Wake Atoll Kiosk Video” and also interface the “push start video button” and the Raspberry Pi 3. The Video Looper program for the Raspberry Pi 3 is open-source and available for download online.

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The surge protector/multi-plug will allow for all electronics to be internally powered and electronically protected in the event of electrical surge. Wall outlets within the proposed location of the Kiosk are 110 Volt AC. A heavy gauge three prong extension wire will be connected from wall outlet to Kiosk where it is connected, via a small built-in outlet box, to the base of the Kiosk’s rear face. Connected to the outlet box and within the interior of the Kiosk, the surge protector/multi-plug, of which the plug fascia (5 plug minimum) will be mounted with screws horizontally to the utility shelf.

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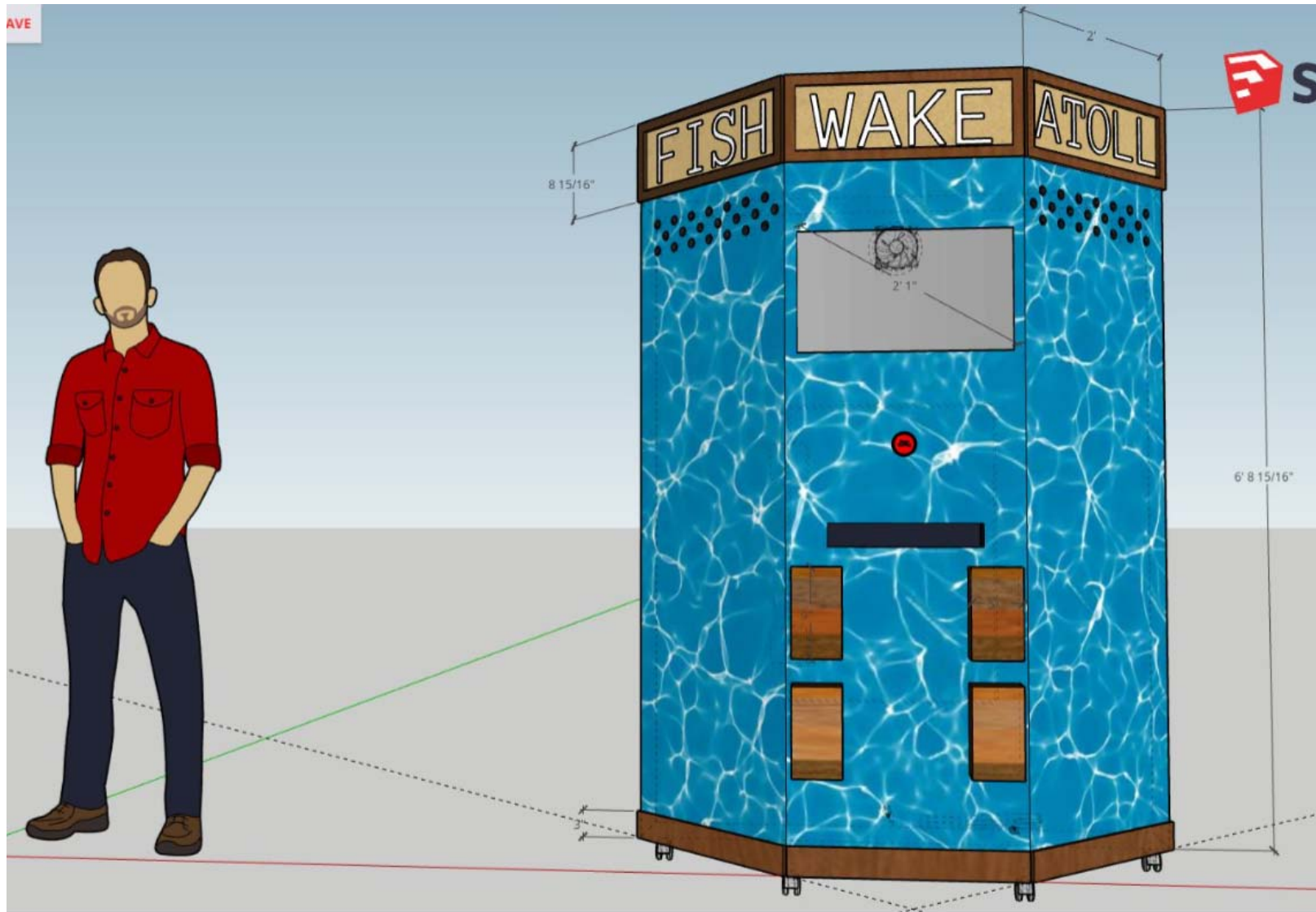


Figure K-1: Front View of Kiosk conceptual design showing display, holders for pamphlets and catch reporting cards, and report deposit slot. Materials will be bi-lingual in English and Thai.

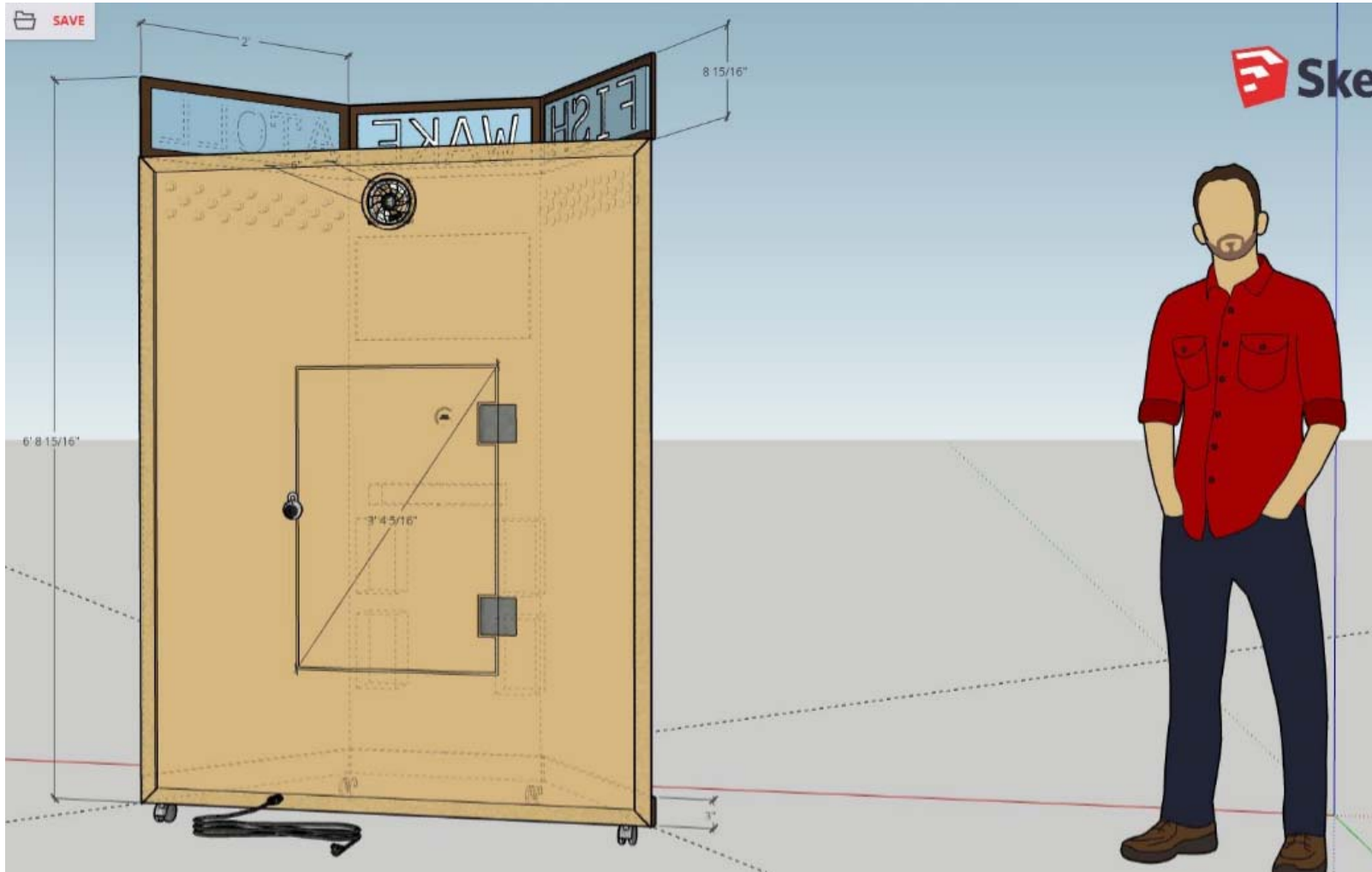


Figure K-2: Rear View of Kiosk conceptual design cover, cabinet door, lock, ventilation fan, and electrical extension chord.

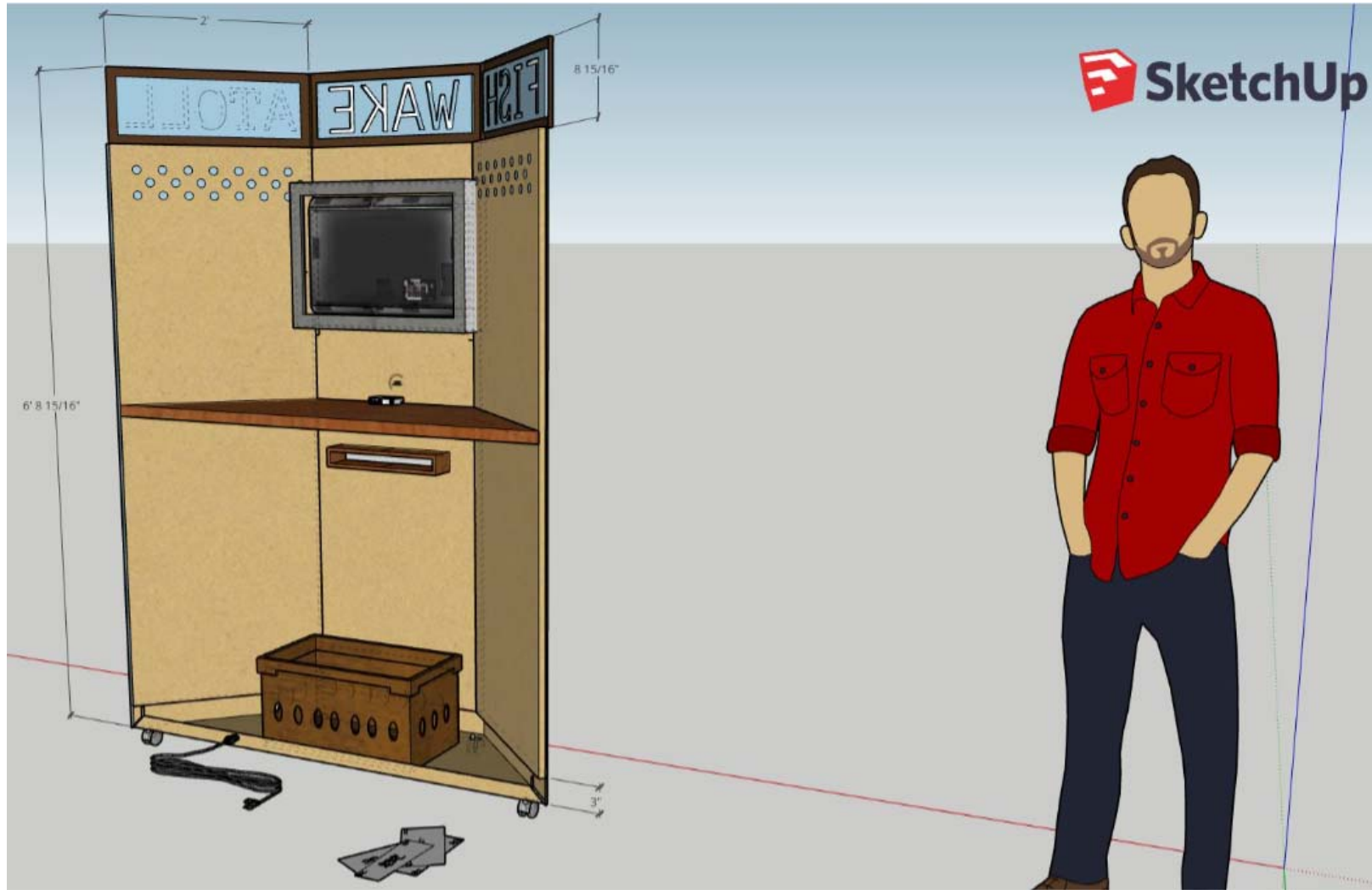


Figure K-3: Conceptual design showing with covers removed to provide a view of the inside of the Kiosk. View shows bin for turned in catch reporting cards, screen mounting detail, and a shelf that would have extra pamphlets and catch reporting cards, and would hold electronic hardware.



Raspberry Pi 3 set



21.5 inch monitor compatible with the Pi 3



Example of speakers

Figure K-4: Electronic hardware for Kiosk video operation.

Extraordinary Aggressive Behavior from the Giant Coral Reef Fish, *Bolbometopon muricatum*, in a Remote Marine Reserve

Roldan C. Muñoz^{1*}, Brian J. Zgliczynski², Joseph L. Laughlin³, Bradford Z. Teer¹

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Abstract

Human impacts to terrestrial and marine communities are widespread and typically begin with the local extirpation of large-bodied animals. In the marine environment, few pristine areas relatively free of human impact remain to provide baselines of ecosystem function and goals for restoration efforts. Recent comparisons of remote and/or protected coral reefs versus impacted sites suggest remote systems are dominated by apex predators, yet in these systems the ecological role of non-predatory, large-bodied, highly vulnerable species such as the giant bumphead parrotfish (*Bolbometopon muricatum*) has received less attention. Overfishing of *Bolbometopon* has led to precipitous declines in population density and avoidance of humans throughout its range, contributing to its status as a candidate species under the U. S. Endangered Species Act and limiting opportunities to study unexploited populations. Here we show that extraordinary ecological processes, such as violent headbutting contests by the world's largest parrotfish, can be revealed by studying unexploited ecosystems, such as the coral reefs of Wake Atoll where we studied an abundant population of *Bolbometopon*. *Bolbometopon* is among the largest of coral reef fishes and is a well known, charismatic species, yet to our knowledge, no scientific documentation of ritualized headbutting exists for marine fishes. Our observations of aggressive headbutting by *Bolbometopon* underscore that remote locations and marine reserves, by inhibiting negative responses to human observers and by allowing the persistence of historical conditions, can provide valuable opportunities to study ecosystems in their natural state, thereby facilitating the discovery, conservation, and interpretation of a range of sometimes remarkable behavioral and ecological processes.

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Introduction

For large-bodied species that are generally first to be extirpated following human contact [1,2], no-take protected areas and remote locations relatively free of human impact can harbor extraordinary ecological processes. In the marine environment, few pristine areas unaffected by human activities such as fisheries exploitation remain to provide baselines of ecosystem function and goals for restoration efforts [3]. Recent comparisons of remote and/or protected coral reefs versus impacted sites suggest remote systems are dominated by apex predators [4], yet the ecological role in these systems of non-predatory, large-bodied, highly vulnerable species such as the giant bumphead parrotfish (*Bolbometopon muricatum*) has received less attention.

Bolbometopon is the largest herbivorous fish on coral reefs, reaching 150 cm total length (TL) and over 75 kg total weight [5]. It is slow-growing and long-lived with delayed reproduction and low replenishment rates [6,7,8]. As a result, even moderate levels of exploitation have led to severe declines in size-structure and abundance of populations throughout much of its range [9,10,11].

In addition, *Bolbometopon* often sleeps and feeds in large groups in shallow water and shows strong site fidelity, making it highly vulnerable to exploitation by night spearfishing and netting of daytime feeding schools [12,13]. For example, night spearfishing increased with the advent of underwater flashlights in the 1970's, and in the western Solomon Islands led to overexploitation and the disappearance of sleeping aggregations that had persisted and supported subsistence fishing for generations [14]. Overfishing has led to a general avoidance of humans; it is known as the wariest of parrotfishes and in most locations individuals are difficult to approach underwater [15]. *Bolbometopon* was listed as Vulnerable in 2007 by the International Union for Conservation of Nature (IUCN), and became a candidate species under the U. S. Endangered Species Act in 2010.

One location where the ecological role of *Bolbometopon* has been studied is Australia's Great Barrier Reef (GBR). The GBR has no commercial fisheries for parrotfishes. As such, these reefs support healthy populations of giant bumphead parrotfish where schools of 30–50 individuals can be observed regularly [6,16]. On the GBR, individuals appear capable of bioeroding over 5 tons of reef

carbonate each year [16]. Because of its large size, feeding rates, and schooling behavior, *Bolbometopon* may play a keystone role as a major coral consumer and bioeroder on coral reefs. In overfished locations, negative effects may include significant disruption to coral community structure, reductions in reef structural stability via invasive erosion by echinoids, and dramatic reductions in sediment transport [16]. Given *Bolbometopon*'s vulnerability to overexploitation and ecological role, comparative studies of its biology and ecology from additional unexploited populations are urgently needed and may provide critical insights for the development of recovery and management plans throughout its range. We studied spawning site characteristics and reproductive behavior of such a population at Wake Atoll, a U. S. Marine National Monument where great abundances of *Bolbometopon* can be commonly observed (Fig. 1a). On its spawning grounds, we witnessed spectacular displays of aggressive behavior between males which we describe here.

Results and Discussion

While observing large aggregations of *Bolbometopon* in ~7 m of water, we heard loud jarring sounds and confirmed they arose from violent impacts between males engaged in repeated, ritualized headbutting behavior (Fig. 1, Video S1, Video S2). During headbutting bouts, males utilized their caudal fins to rapidly collide with their cephalic humps, immediately followed by

fast swimming in a semicircle where each fish tried to bite the back and flank of its opponent (Fig. 1d). Following circling, fish swam apart in opposite directions and then turned again face to face to initiate additional collisions. Impact sounds and headbutting were documented on multiple occasions (five and two separate days, respectively) from approximately 0630–0815 h, coincided (in all but one case) with days where we also observed spawning, and were only observed or heard in locations where spawning was also observed. During our study sunrise occurred from 0633–0637 h.

To our knowledge, no scientific documentation of ritualized headbutting exists for marine fishes. *Bolbometopon* is the world's largest parrotfish and is among the largest of coral reef fishes. How could this dramatic aspect of its social and reproductive behavior have gone unnoticed? We propose two reasons: 1) Low population densities resulting from overfishing dampen competition for resources (females or spawning territories) and/or disrupt the social system [17] so that headbutting contests are uncommon and no longer advantageous. 2) Headbutting contests are common, but negative responses to humans in exploited populations preclude observations of natural behavior. Quantitative estimates of historical abundance are not readily available for *Bolbometopon*, but numerous sources employing indigenous ecological knowledge indicate that precipitous declines in giant bumphead parrotfish populations and decreases in catches correspond with increases in fishing pressure via the advent of spear guns and underwater flashlights [11,13,18,19]. Reports include catching “250 in one

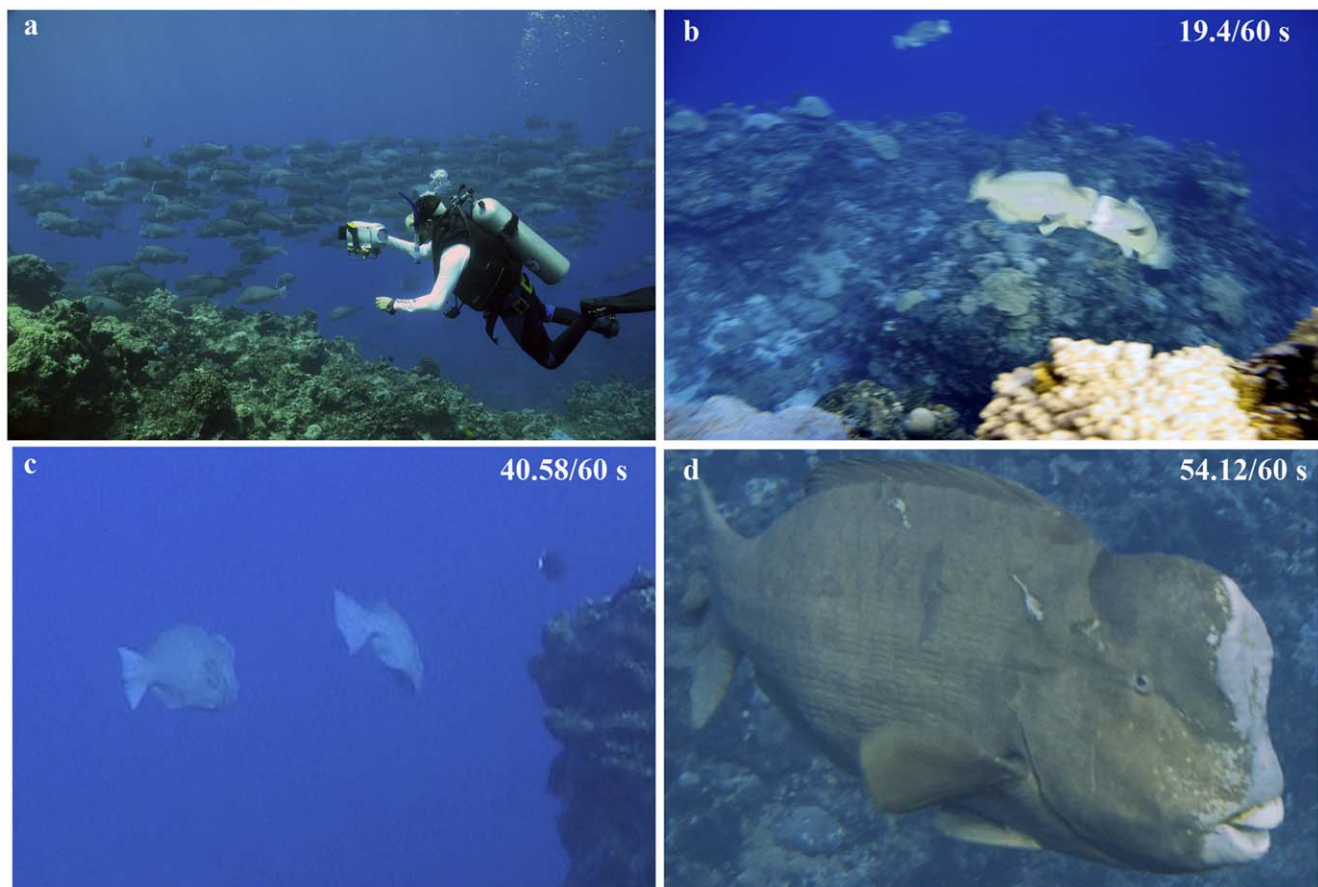


Figure 1. *Bolbometopon muricatum* at Wake Atoll. (a) Partial spawning aggregation of *Bolbometopon* consisting of 246 individuals. (b) Second headbutting impact. Time corresponds with video. (c) Capitulation by subordinate male (on right) rapidly fleeing the area with use of caudal fin following fourth charge. (d) Dominant male showing scale damage on back and side following headbutting bout.
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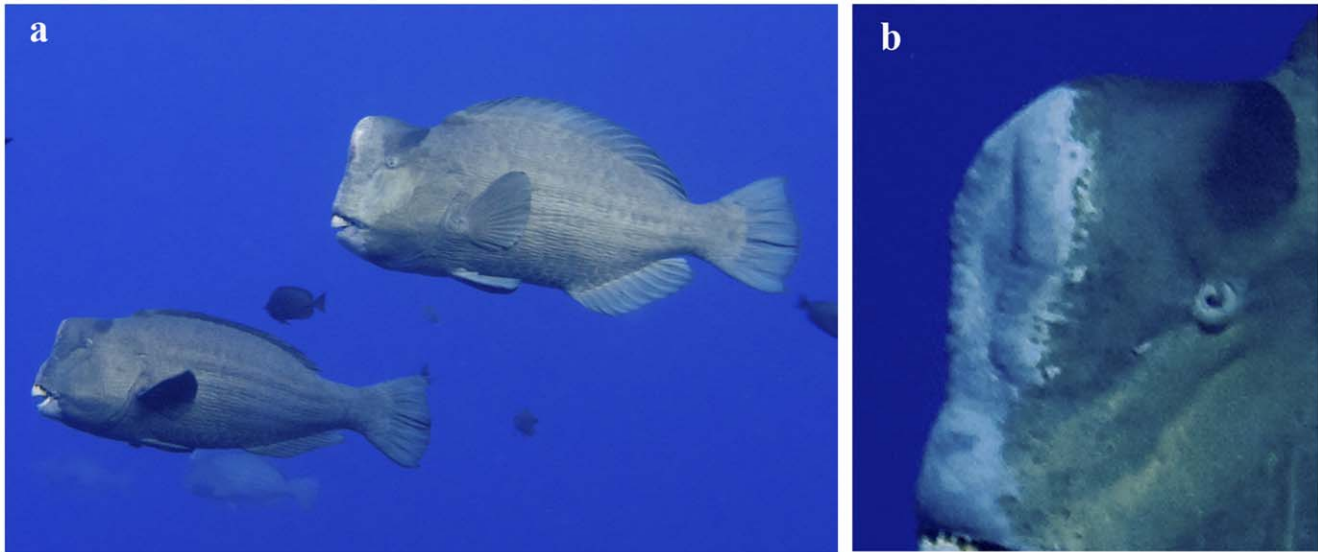


Figure 2. Sexual dimorphism in *Bolbometopon muricatum*. (a) Female *Bolbometopon* (lower fish) and male (upper), illustrating dimorphic forehead profile which slopes caudal to beak in females but is nearly parallel with beak in males. Males are also typically larger than females [8]. All observations of courtship and spawning that we observed were between dimorphic fish, suggesting that sex can be determined in the field based on a combination of morphology and behavior [37,38]. This assumes that most female fish interacting with morphological and behavioral males are indeed female (but see [8,37,39, Muñoz et al. in prep]). (b) Detail of male forehead showing ossified ridge characteristic of large males. The ossified ridge and cephalic hump are reduced in females. doi:10.1371/journal.pone.0038120.g002

night of spearing in shallow water, could catch the whole school on scuba in the 1970's, and after 1975, 30–50 fish per trip, and nowadays very few." Another indirect mechanism used to estimate historical numbers is to compare *Bolbometopon* densities relative to areas of low human population density or exploitation levels [11,12,20]. With this approach, unexploited areas appear to support 4–48 fish per ha compared with no individuals observed in areas of heavy exploitation.

We hypothesize that geographic isolation and the lack of fisheries exploitation allow historical population densities and traditional spawning sites of *Bolbometopon* to persist. At sites where *Bolbometopon* are abundant, intense competition [21], sexual selection, and aggressive headbutting contests can be observed. In addition, the protected status of *Bolbometopon* at Wake Atoll results in neutral responses to divers, allowing the unexploited behavioral ecology of this threatened species to be studied.

The context of headbutting in *Bolbometopon* appears similar to the well-known male-male aggressive contests in cetartiodactyls (even-toed ungulates and cetaceans), examples of intrasexual selection where males establish dominance hierarchies or defend territories before mating [22]. As in cetartiodactyls and aggressive contests in general, the physical act of headbutting is likely on the extreme end of a continuum of aggression, with most contests being settled with non-contact displays. For example, male red deer initially roar to settle contests, then proceed to parallel walks, and only later move to violent headbutting/interlocking antlers that carry potential serious costs [23]. We witnessed far more male-male parallel swim displays than we heard impact sounds.

Though rumored to use their forehead to ram corals prior to ingestion [15], the enlarged cephalic hump of *Bolbometopon* may be a classic example of a secondary sexual characteristic resulting from sexual selection (Fig. 2a), such as the massive horns in male bighorn sheep (*Ovis canadensis*). In addition, *Bolbometopon* males exhibit what appears to be an "ossified ridge" on the forehead (Fig. 2b) that may serve a similar function as the cranial appendages of artiodactyls. Any correlations between male hump,

body size, and mating success remain to be determined. Freshwater cyprinid (minnows) and mormyrid (elephantfishes) species are reported to headbutt, but males do not display morphological characters (cranial appendages) associated with headbutting (but see breeding tubercles) [24,25,26]. In addition, physical contact in these fishes is not confined to the forehead but may also be directed at the body or tail.

Density-dependent alternative mating systems are well known in labroid fishes, but many alternatives only appear at elevated population densities [27] likely resembling conditions in which the systems evolved. Since historical densities have become exceedingly rare for large-bodied species, some alternatives may seldom be observed (a single observation of headbutting by *Bolbometopon* was reported in a recreational dive blog from the Red Sea, an area where *Bolbometopon* is reported to be locally abundant, [11,28]), and odd morphologies will remain difficult to interpret. Our observations of aggressive headbutting by *Bolbometopon* at Wake Atoll underscore that remote locations and marine reserves, by inhibiting negative responses to human observers and by allowing the persistence of historical conditions, can provide vital opportunities to study ecosystems in their natural state, thereby facilitating the discovery, conservation, and interpretation of a range of behavioral phenotypes.

Materials and Methods

Permission to conduct field research at Wake Island was granted by Eureka T. Dotson, Major, United States Air Force, Commander, DET 1, 611 ASG, PO Box 68, Wake Island, HI, 96898. All research was conducted in accordance with the Animal Welfare Act (AWA) and with the U.S. Government Principles for the Utilization and Care of Vertebrate Animals Used in Testing, Research, and Training (USGP) OSTP CFR May 20, 1985, Vol.50, No. 97. The study was conducted on free-living wild animals in their natural habitat and solely involved observations of animals and noninvasive measurements.

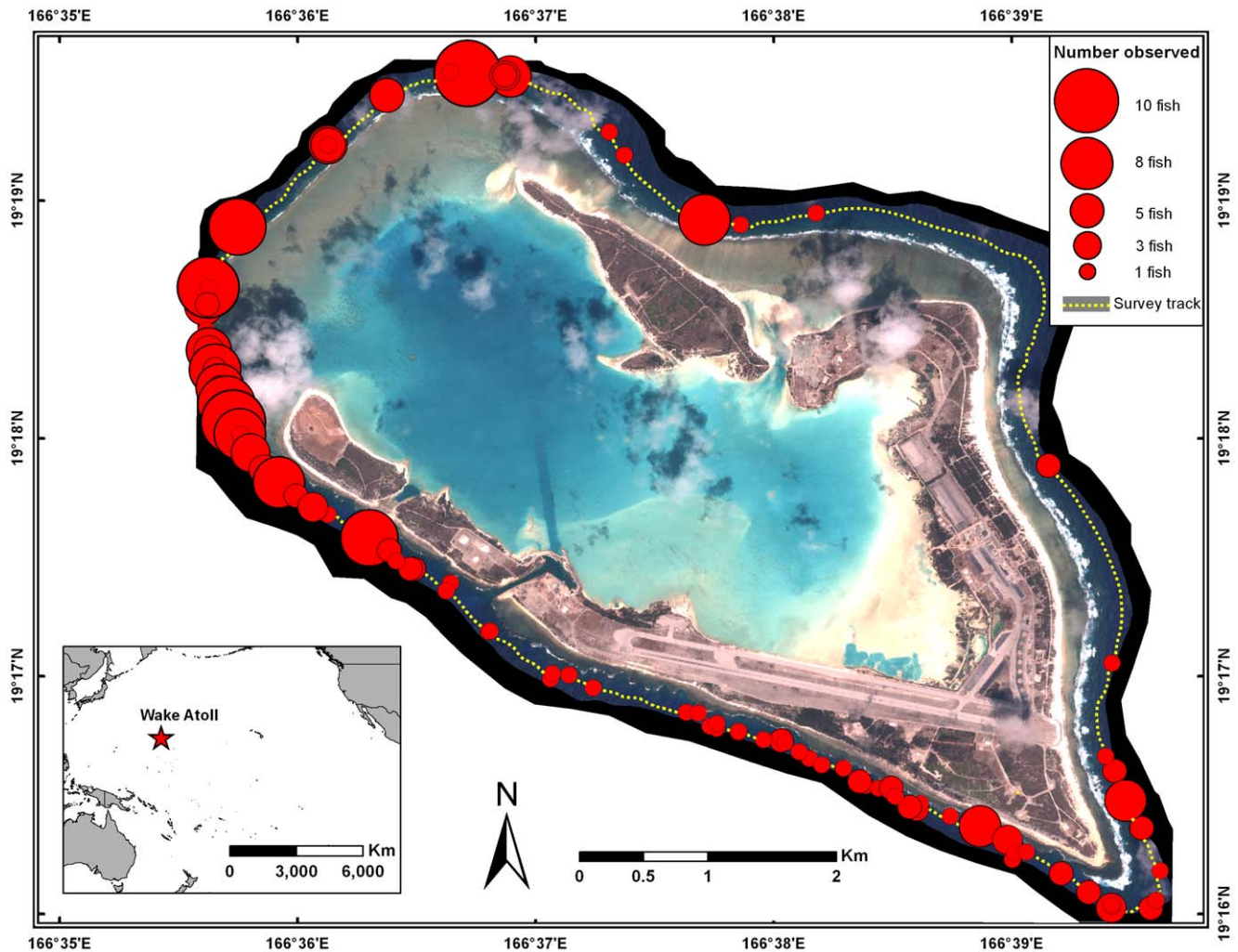


Figure 3. Distribution of *Bolbometopon muricatum* at Wake Atoll observed during towed-diver surveys from 2005–2009. Surveys were conducted on a biennial basis by the NOAA Coral Reef Ecosystem Division. Circles indicate the total number of fish observed at each location around the atoll.

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Wake Atoll (19° 18' N, 166° 37' E), is a U. S. Pacific Remote Island, National Wildlife Refuge, and recently designated Marine National Monument co-managed by the U. S. Department of Defense (DOD) and the U. S. Fish and Wildlife Service (USFWS). We conducted 100 h of snorkel and scuba observations of giant bumphead parrotfish (*Bolbometopon muricatum*, Labridae, Scarinae, [29]) from 12–25 August 2011. Visibility ranged from 4.5 m to >30 m, depending on the tidal state (ebbing tide drained the atoll lagoon, decreasing visibility). General underwater conditions can be found in Lobel and Lobel [30]. We chose study sites along the outer fore reef based on the densities of *Bolbometopon* from previous towed-diver surveys by the U. S. National Marine Fisheries Service Coral Reef Ecosystem Division, which conducts biennial surveys of the coral reef ecosystem at Wake Atoll (Fig. 3). Detailed survey methods can be found in Richards et al. [31]. Briefly, divers maneuvered towboards 1–3 m above the substrate and tallied all fishes ≥ 50 cm TL that entered a 10 m wide swath centered on and forward of the diver. Surveys were 50 min in duration and observational data were recorded in 10 5-min segments. A total of 51 towed-diver surveys were completed during research cruises in 2005, 2007, and 2009. Surveys circumnavigated the island and over 29.64 ha of reef area were surveyed around Wake Atoll

during each survey year. The spatial consistency of increased *Bolbometopon* densities in the SW side of the island across years suggests that *Bolbometopon* may form true fish spawning aggregations at Wake Atoll (*sensu* Domeier [32]); we will present additional analyses that further examine this possibility in a related paper (Muñoz et al. in prep). Because of its remote location and its administration by DOD (since 1934) and USFWS, commercial fishing at Wake Atoll has been excluded and all fishing for *Bolbometopon* is prohibited, so populations can be considered pristine (island-wide mean of 2.97 individuals per ha [SE 0.96], Fig. 1a) [33,34].

We recorded spawning behavior of *Bolbometopon* using high definition video (Canon Vixia HF S200, Sony HDR-HC9), and still photography (Nikon D300, Canon G9). Observations took place during daylight hours using snorkel, scuba, and towed-diver surveys and were geographically logged with a hand-held GPS [35,36].

Supporting Information

Video S1 Ritualized headbutting of *Bolbometopon muricatum* at Wake Atoll. We captured an entire headbutting bout

on high definition video, consisting of four, successive charges between two males. The first three resulted in impact (~5.8/60 s [audible but outside field of view], 19.4/60 s, 26.58/60 s), and the fourth charge resulted in the subordinate male fleeing the contest. Full sequence at normal speed. Given the distinctive sounds from headbutting, once identified, spawning grounds could be monitored with Ecological Acoustic Recorders [40] to assess reproductive effort and aid in the management of this threatened species. (MP4)

Video S2 Ritualized headbutting of *Bolbometopon muricatum* at Wake Atoll. We captured an entire headbutting bout on high definition video, consisting of four, successive charges between two males. This video shows detail of charges presented in Video S1 at half speed. (MP4)

References

- Jackson JBC, Kirby MX, Berger WH, Bjorndal KA, Botsford LW, et al. (2001) Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293: 629–638.
- Morrison JC, Sechrest W, Dinerstein E, Wilcove DS, Lamoreux JF (2007) Persistence of large mammal faunas as indicators of global human impacts. *Journal of Mammalogy* 88: 1363–1380.
- Knowlton N, Jackson JBC (2008) Shifting baselines, local impacts, and global change on coral reefs. *Plos Biology* 6: 215–220.
- DeMartini EE, Friedlander AM, Sandin SA, Sala E (2008) Differences in fish-assemblage structure between fished and unfished atolls in the northern Line Islands, central Pacific. *Marine Ecology-Progress Series* 365: 199–215.
- Gladstone W (1986) Spawning behavior of the bumphead parrotfish *Bolbometopon muricatum* at Yonge Reef, Great Barrier Reef. *Japanese Journal of Ichthyology* 33: 326–328.
- Bellwood DR, Choat JH (2011) Dangerous demographics: the lack of juvenile humphead parrotfishes *Bolbometopon muricatum* on the Great Barrier Reef. *Coral Reefs* 30: 549–554.
- Choat JH, Robertson DR (2002) Age-based studies on coral reef fishes. In: Sale PF, ed. *Coral reef fishes: Dynamics and diversity in a complex ecosystem*. San Diego: Academic Press. pp 57–80.
- Hamilton RJ, Adams S, Choat JH (2008) Sexual development and reproductive demography of the green humphead parrotfish (*Bolbometopon muricatum*) in the Solomon Islands. *Coral Reefs* 27: 153–163.
- Aswani S, Hamilton RJ (2004) Integrating indigenous ecological knowledge and customary sea tenure with marine and social science for conservation of bumphead parrotfish (*Bolbometopon muricatum*) in the Roviana Lagoon, Solomon Islands. *Environmental Conservation* 31: 69–83.
- Donaldson TJ, Dulvy NK (2004) Threatened fishes of the world: *Bolbometopon muricatum* (Valenciennes 1840) (Scaridae). *Environmental Biology of Fishes* 70: 373.
- Dulvy NK, Polunin NVC (2004) Using informal knowledge to infer human-induced rarity of a conspicuous reef fish. *Animal Conservation* 7: 365–374.
- Hamilton RJ, Choat JH (2012) Bumphead Parrotfish – *Bolbometopon muricatum*. In: Sadovy de Mitcheson Y, Colin PL, eds. *Reef Fish Spawning Aggregations: Biology, Research and Management, Fish & Fisheries Series: Springer, Springer Science+Business Media B.V.* pp 490–496.
- Johannes RE (1981) *Words of the lagoon: fishing and marine lore in the Palau District of Micronesia*. Berkeley/Los Angeles/London: University of California Press.
- Hamilton RJ (2004) The demographics of bumphead parrotfish (*Bolbometopon muricatum*) in lightly and heavily fished regions of the Western Solomon Islands. [Ph.D. thesis]. Dunedin, New Zealand: University of Otago. 273 p.
- Myers RF (1999) *Micronesian reef fishes: A field guide for divers and aquarists*. Barrigada: Coral Graphics, Guam Main Facility. 330 p.
- Bellwood DR, Hoey AS, Choat JH (2003) Limited functional redundancy in high diversity systems: resilience and ecosystem function on coral reefs. *Ecology Letters* 6: 281–285.
- Muñoz RC, Burton ML, Brennan KJ, Parker RO (2010) Reproduction, habitat utilization, and movements of hogfish (*Lachnolaimus maximus*) in the Florida Keys, U. S. A.: comparisons from fished versus unfished habitats. *Bulletin of Marine Science* 86: 93–116.
- Hamilton RJ, Paiva F, Aitsi J, Potuku P, Siota C, et al. (2010) Northern Bougainville Marine Resource Assessment, Autonomous Region of Bougainville. Technical report of survey conducted from the 1st–25th November 2008. A report by the Marine Program of the Asia Pacific Conservation Region, The Nature Conservancy. 2/ 10.
- Sadovy YJ (2007) Report on current status and exploitation history of reef fish spawning aggregations in Palau. *Western Pacific Fishery Survey Series: Society for the Conservation of Reef Fish Aggregations, Volume 3. SCRFA and the Palau Conservation Society*.
- Bellwood DR, Hoey AS, Hughes TP (2012) Human activity selectively impacts the ecosystem roles of parrotfishes on coral reefs. *Proceedings of the Royal Society B-Biological Sciences* 279: 1621–1629.
- Roberts CM, Polunin NVC (1991) Are marine reserves effective in management of reef fisheries? *Reviews in Fish Biology and Fisheries* 1: 65–91.
- Lusseau D (2003) The emergence of cetaceans: phylogenetic analysis of male social behaviour supports the Cetartiodactyla clade. *Journal of Evolutionary Biology* 16: 531–535.
- Clutton-Brock TH, Albon SD (1979) The roaring of red deer and the evolution of honest advertisement. *Behaviour* 69: 145–170.
- Kortet R, Taskinen J, Vainikka A, Ylonen H (2004) Breeding tubercles, papillomatosis and dominance behaviour of male roach (*Rutilus rutilus*) during the spawning period. *Ethology* 110: 591–601.
- Phillips CT, Gibson JR, Fries JN (2011) Spawning behavior and nest association by *Dianda diaboli* in the Devils River, Texas. *Southwestern Naturalist* 56: 108–112.
- Terleph TA (2004) The function of agonistic display behaviours in *Gnathonemus petersii*. *Journal of Fish Biology* 64: 1373–1385.
- Warner RR, Hoffman SG (1980) Local population size as a determinant of mating system and sexual composition in two tropical reef fishes (*Thalassoma* spp.). *Evolution* 34: 508–518.
- Anonymous (2009) Southern Sudan Odyssey. *DiverNet-Diver Magazine* online and much more. Available: http://www.divernet.com/Travel_Features/red_sea/302280/southern_sudan_odyssey.html. Accessed 2012 May 7.
- Westneat MW, Alfaro ME (2005) Phylogenetic relationships and evolutionary history of the reef fish family Labridae. *Molecular Phylogenetics and Evolution* 36: 370–390.
- Lobel PS, Lobel LK (2008) Aspects of the biology and geomorphology of Johnston and Wake atolls, Pacific Ocean. In: Riegl BM, Dodge RE, eds. *Coral reefs of the USA*. Berlin: Springer. pp 655–689.
- Richards BL, Williams ID, Nadon MO, Zgliczynski BJ (2011) A towed-diver survey method for mesoscale fishery-independent assessment of large-bodied reef fishes. *Bulletin of Marine Science* 87: 55–74.
- Domeier M (2012) Revisiting Spawning Aggregations: Definitions and Challenges. In: Sadovy de Mitcheson Y, Colin PL, eds. *Reef Fish Spawning Aggregations: Biology, Research and Management, Fish & Fisheries Series: Springer, Springer Science+Business Media B.V.* pp 1–20.
- Lobel PS, Lobel LK (2004) Annotated checklist of the fishes of Wake Atoll. *Pacific Science* 58: 65–90.
- Zgliczynski BJ, Williams ID, Schroader R, Nadon MO, Richards BL, et al. (In Review) Distribution and abundance of IUCN Red-listed coral reef fishes in the US Pacific Islands. *Coral Reefs*.
- Nanami A, Yamada H (2008) Size and spatial arrangement of home range of checkered snapper *Lutjanus decussatus* (Lutjanidae) in an Okinawan coral reef determined using a portable GPS receiver. *Marine Biology* 153: 1103–1111.
- Colin PL (2012) Studying and Monitoring Aggregating Species. In: Sadovy de Mitcheson Y, Colin PL, eds. *Reef Fish Spawning Aggregations: Biology, Research and Management, Fish & Fisheries Series: Springer, Springer Science+Business Media B.V.* pp 285–329.
- Warner RR, Robertson DR (1978) Sexual patterns in the labroid fishes of the Western Caribbean, I: The wrasses (Labridae). *Smithsonian Contributions to Zoology* 254: 1–27.
- Miranda A, Almeida OG, Hubbard PC, Barata EN, Canario AVM (2005) Olfactory discrimination of female reproductive status by male tilapia (*Oreochromis mossambicus*). *Journal of Experimental Biology* 208: 2037–2043.
- Suzuki S, Toguchi K, Makino Y, Kuwamura T, Nakashima Y, et al. (2008) Group spawning results from the streaking of small males into a sneaking pair: male alternative reproductive tactics in the threespot wrasse *Halichoeres trimaculatus*. *Journal of Ethology* 26: 397–404.

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Author Contributions

Wrote the paper: RCM BJZ. Conceived and designed the study: RCM BJZ. Collected the data: RCM BJZ JLL BZT. Reviewed and edited the manuscript: RCM BJZ JLL BZT.

40. Lammers MO, Brainard RE, Au WWL, Mooney TA, Wong KB (2008) An ecological acoustic recorder (EAR) for long-term monitoring of biological and anthropogenic sounds on coral reefs and other marine habitats. *Journal of the Acoustical Society of America* 123: 1720–1728.

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Lease vs. Buy Evaluation Factors

The NFE shall provide a cost analysis for Lease vs. Buy factors. The following factors shall be considered at a minimum, and shall contain numerical values where applicable.

Factors	Lease	Buy
Estimated Period of Use/Extent of Use		
Financial Advantages		
Cumulative Rental Payments for Estimated Time Period		
Transportation and Installation Costs		
Maintenance & Other Service Costs		
Potential Obsolescence of equipment due to imminent technological improvements		
Availability of Purchase Options		
Potential for Use by other Agencies after preliminary use has ended		
Trade-in or Salvage Value		
Imputed Interest		
Can the equipment be serviced by the government or other sources if it is purchased?		
Total Cost:		

Factors	Lease	Buy
Estimated Period of Use/Extent of Use		
Financial Advantages		
Cumulative Rental Payments for Estimated Time Period		
Transportation and Installation Costs		
Maintenance & Other Service Costs		
Potential Obsolescence of equipment due to imminent technological improvements		
Availability of Purchase Options		
Potential for Use by other Agencies after preliminary use has ended		
Trade-in or Salvage Value		
Imputed Interest		
Can the equipment be serviced by the government or other sources if it is purchased?		
Total Cost:		

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INRMP MARINE SURVEYS WAKE ISLAND AIRFIELD, USA

Project Past Performance

Project Name,	
Project Location:	
Contract or Cooperative Agreement #:	
Size (Value):	
Technical Complexity:	
Technical Team Utilized:	
Point of Contact(s): Provide Email and phone number	