



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Islands Fisheries Science Center
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PROJECT REPORT

VESSEL: *Oscar Elton Sette*, Project SE-18-05

PROJECT PERIOD: September 19–October 11, 2018

AREA OF OPERATION: The operating area consisted of the islands and atolls of the Papahānaumokuākea Marine National Monument. Operations took place at Pearl and Hermes Atoll, Midway Atoll, Lisianski Island and Maro Reef.

TYPE OF OPERATION: The NOAA Ship *Oscar Elton Sette* (*OES*) was engaged as support for a NOAA National Marine Fisheries Service (NMFS) Pacific Islands Fisheries Science Center (PIFSC) Ecosystem Sciences Division (ESD) Marine Debris Project. The ship supported in-water marine debris survey and removal operations Pearl and Hermes Atoll. The marine debris (primarily derelict fishing gear) collected during survey and removal operations was stored onboard until the vessel returned to Ford Island, Pearl Harbor. In addition to marine debris survey and removal efforts, sUAS (small unmanned aerial system) flights and Structure from Motion (SfM) surveys were conducted at Pearl and Hermes Atoll, and acoustic instrumentation was deployed at Lisianski Island and Maro Reef.

ITINERARY:
19 September **Pearl Harbor:** Departed 1200
Embarked scientists Tomoko Acoba, Matthew Chauvin, Tessa Code, Joao Garriques, Steven Gnam, Andrew Gray, Ariel Halperin, Kristen Kelly, Josh Levy, Kaylyn McCoy, Andrew McWhirter, James Morioka, Kevin O'Brien, Michael Pamatat, Jessica Schem, Rhonda Suka, Rebecca Weible, Tate Wester, and Kelly Williams.



- 19-23 September **Transit**
 During transit, drills and welcome-aboard orientations occurred. Final patching was done to small boat F1926 and the first days of operations were planned.
- 23 September **Pearl and Hermes Atoll:** Arrived PHR at 1330.
 Conducted small boat launch and recovery practice on the south side of the atoll to familiarize the team with launch and recovery operations.
- 24 September **Pearl and Hermes Atoll:**
 Four program boats conducted survey and removal operations in the lagoon at PHR.
 Swim surveys were conducted over 0.26 km² of reticulated reef.
 2,111 kg (4,650 lb) of DFG was removed.
 (2) sUAS flights (quadcopter) were conducted by Steven Gnam in support of outreach photography.
- 25 September **Pearl and Hermes Atoll:**
 Four program boats conducted debris survey and removal operations. SE-4 conducted (9) SfM surveys of previously marked nets and control sites.
 Swim surveys were conducted over 0.22 km² of reticulated reef.
 2,550 kg (5,620 lb) of DFG was removed
- 26 September **Pearl and Hermes Atoll**
 Four program boats conducted debris survey and removal operations SE-4 conducted (6) SfM surveys of previously marked nets and control sites
 Swim surveys were conducted over 0.188 km² of reticulated reef.
 1,912 kg (4,215 lb) of DFG was removed
- 27 September **Pearl and Hermes Atoll:**
 Four program boats conducted debris survey and removal operations SE-4 conducted (9) SfM surveys of previously marked nets and control sites
 Swim surveys were conducted over 0.16 km² of reticulated reef.
 3,656 kg (8,060 lb) of DFG was removed.
 (7) sUAS flights were conducted.

- 28 September **Pearl and Hermes Atoll:**
 Four program boats conducted debris survey and removal operations
 SE-4 conducted (6) SfM surveys of previously marked nets and control sites
 Swim surveys were conducted over 0.29 km² of reticulated reef.
 3,160 kg (6,966 lb) of derelict fishing gear was removed.
 (10) sUAS flights were conducted.
 (1) HIMB Shark tag receiver was recovered from PHR South (Big Boat Channel).
- 29 September **Pearl and Hermes Atoll:**
 Four program boats conducted debris survey and removal operations
 Swim surveys were conducted over 0.21 km² of reticulated reef.
 4,336 kg (9,559 lb) of derelict fishing gear was removed.
 (4) satellite trackers were deployed on nets located along the eastern fringing reef and the northern maze area.
 (3) SfM surveys were conducted of previously marked nets and control sites.
 (6) sUAS flights were conducted (3 Net detection flights, 3 Outreach photography flights).
 (1) HARP recovered and (1) HARP deployed at PHR East.
- 30 September **Pearl and Hermes Atoll:**
 Four program boats conducted debris survey and removal operations
 Swim surveys were conducted over 0.18 km² of reticulated reef.
 2,724 kg (6,005 lb) of derelict fishing gear was removed.
 (2) satellite trackers were deployed on nets located in the northern maze area.
 (18) SfM surveys were conducted of previously marked nets and control sites.
 (4) sUAS flights were conducted (1 Net detection flights, 3 Outreach photography flights).
- 1 October **Pearl and Hermes Atoll:**
 Four program boats conducted debris survey and removal operations
 Swim surveys were conducted over 0.19 km² of reticulated reef.
 1,008 kg (2,222 lb) of derelict fishing gear was removed
 (4) SfM surveys were conducted, completing the allocation for each strata.
 Tow surveys were conducted to ground-truth UAS survey area along the northeast backreef.
 Removed a 680 kg (1,500 lb) Japanese ATON (navigational buoy) from the reef inside the maze.

- 2 October **Pearl and Hermes Atoll:**
 Two program boats conducted debris survey and removal operations
 SE-4 conducted photomosaic surveys
 Swim surveys were conducted over 0.11 km² of reticulated reef.
 1,292 kg (2,848 lb) of derelict fishing gear was removed.
 (2) SfM surveys were conducted.
- 3 October **Pearl and Hermes Atoll:**
 Departed 1700
 Two program boats conducted debris survey and removal operations.
 SE-4 conducted photomosaic surveys.
 Swim surveys were conducted over 0.13 km² of reticulated reef.
 909 kg (2,004 lb) of DFG was removed.
 (4) SfM surveys were conducted.
 (1) green sea turtle was rescued (disentangled and freed) from a net that
 was wound around its neck.
- 4–5 October **Midway Atoll** Arrived 1330 October 4.
 Disembarked scientists Matthew Chauvin, Tessa Code, Joao Garriques,
 Steven Gnam, Andrew Gray, Kristen Kelly, Andrew McWhirter, James
 Morioka, Kevin O’Brien, Michael Pamatat, Jessica Schem, Rhonda
 Suka, Rebecca Weible, Tate Wester, and Kelly Williams.
 Offloaded four program boats and operational gear.
 Departed Midway ~1300 Oct 5 for Lisianski Island.
- 6 October **Lisianski Island** Arrived ~1300
 Deployed (1) Ecological Acoustic Recorder (EAR).
 Attempted unsuccessful recovery of (1) EAR.
- 7 October **Maro Reef** Arrived ~1200
 Deployed (1) Ecological Acoustic Recorder (EAR).
- 8–10 October **Transit**
- 11 October **Pearl Harbor:** Arrived 0800
 Disembarked scientists Tomoko Acoba, Ariel Halperin, Josh Levy, and
 Kaylyn McCoy.
 Offloaded 52 MT of DFG.
 Offloaded remaining program equipment.

MISSION AND RESULTS:

A. Survey and Removal of DFG

Over the course of ten operational days, a total of 23,362 kg (51,504 lb) of derelict fishing gear was removed from the waters of Pearl and Hermes Atoll. During that time, a total area of 2.23 km² of reef was surveyed. Of that, 1.99 km² was surveyed via swim and 0.24 km² was surveyed via towed diver survey (Table 1) (Figures 2 and 3). Once located, the DFG was carefully cut from the reef or removed from the substrate and loaded by hand into the small boats for transport to the ship. Upon to return to Honolulu, all DFG was sent to Schnitzer Steel Corp for processing and then transported to the Covanta H-Power facility for incineration and electricity-generation.

B. Structure from Motion (SfM) component

DFG removal sites at Pearl and Hermes Atoll were surveyed to define and quantify ecological impacts as a result of DFG interaction with coral reefs, and to examine successional changes in the coral reef benthic community. DFG nets were located during swim surveys and selected for SfM if the depth was within 1–3 m. All surveys were conducted over hard substrate in the lagoon at Pearl and Hermes. Historical net location data was used to create a strata map of the lagoon using 30 m grid cells. Each cell accounted for the number of nets found over time then weighted by the survey effort (Figure 4).

Five strata were created:

Zero = never surveyed before;

None = surveyed but no net was found;

Low = more than one survey before net was found;

Medium (Chronic) = found nets on more than one survey;

High (Acute) = many nets were found.

A minimum of 3 DFG removal sites and controls were selected within each strata (Table 2). At each selected DFG removal location, a 3 × 3 m plot was established over the center of the net. Two scale bars, each 0.5 m in length were placed at opposite corners of the plot and a single marker was placed at the remaining corners. Zipties were attached to the reef just outside each corner of the plot to aid in locating the plot again for repeat surveys. An overlapping series of photographs were taken at each site before DFG removal, after removal and at a randomly selected control site within the same strata. A total of 21 DFG removal sites and 24 control sites were photographed (Figure 5).

Each day, a mosaic was run at low resolution to ensure adequate coverage and image quality was achieved. Due to the limited time and hardware capabilities available for processing models during the cruise, only one site was chosen for a high-resolution model. The outcome of that model was a high quality image with sub-centimeter spatial accuracy (Figure 6).

The remaining imagery will be processed to create photomosaics and analysis of benthic percent cover (including live coral, broken and shaded coral, recently dead coral, macroalgae, coralline algae, and sediment) using a point count method for each mosaic to be carried out following the cruise.

C. sUAS Detection of DFG

The goal of the sUAS component of this operation was to conduct mapping missions over shallow fringing and patch reefs in Pearl and Hermes Lagoon to determine the functionality of sUAS surveys in detecting DFG. We had permission from NOAA AOC to operate a Flightwave Edge UAS during the NOAA Marine Debris Removal effort in the lagoon of Pearl and Hermes Atoll in Papahānaumokuākea National Marine Monument. Flight operations occurred between September 27 and 30 due to good weather conditions and available boat space. Flights occurred between the hours of 0830 and 1030, and between 1400 and 1600 to avoid high sun angle, and associated large glare spots in the images. We collected imagery at 60, 80, 100, and 120 m to determine the adequate altitude to resolve DFG. Out of the 10 flights, 9 were successful, and 8 collected mapping-quality imagery at 60-m altitude (Figure 7). Both IR and RGB sensors were used to determine the most effective sensor at highlighting DFG from the surrounding scene. We mapped a total area of 3.39 km² in 3.7 hours, which resulted in the collection of 7547 images with 85% overlap between images. Most mapping missions were focused in the main lagoon ‘maze’, with one mission directed over the east edge of the atoll (Figure 8). The scientific question for this project is to understand the efficiency and accuracy of aerial surveys to detect DFG in comparison to traditional swimming and towed swimmer surveys. sUAS surveys were conducted in locations prior to in-situ surveys and debris removal efforts. We will compare the count and location of nets between the aerial and in situ surveys to determine the feasibility of integrating sUAS surveys of DFG into future DFG removal efforts.

D. Satellite Tracking of DFG at Pearl and Hermes Atoll

A total of 6 (six) derelict fishing nets were located via visual survey in the northeastern region of Pearl and Hermes Atoll and left in place for the purpose of satellite tracking. These nets had to be at minimum 75% buoyant and have a minimum in-water volume of 0.5 m³. A satellite tracking buoy was attached to each of these six nets using large industrial cable ties, and then left in place for monitoring. The movements of these nets within the atoll will be tracked over the course of the next year in order to provide more insight into the movement patterns of DFG and better quantify the number of reef interactions a single net can be expected to have over time. The deployment locations and initial movements can be seen in Figure 9.

E. Deployment of Ecological Acoustic Recorder (EAR) Moorings

During the return transit to Honolulu, Ecological Acoustic Recorder (EAR) Moorings were deployed at Lisianski Island and Maro Reef. In addition to the two instrument deployments, one attempt to recover an existing instrument at the same location at Lisianski was conducted, but unfortunately the instrument was unresponsive. These instruments are passive acoustic recording devices intended to record marine mammal and other sounds.

Site	Lat.	Long.	Depth (ft)	Activity
Maro Reef	25.306	-170.669	121	Deploy
Lisianski	26.123	-174.075	104	Deploy/Retrieve

F. Deployment and Recovery of High-frequency Acoustic Recording Package (HARP)

A High-frequency Acoustic Recording Package (HARP) deployment and recovery (swap) was conducted successfully off the southeast side of Pearl and Hermes Atoll on September 29 at location 27 43.6'N, 175 33.3'W.

SCIENTIFIC PERSONNEL:

- Kevin O'Brien, ESD Field Logistics Associate, JIMAR
- James Morioka, ESD Operations Manager, JIMAR
- Joao Garriques, ESD Field Logistics Associate, JIMAR
- Tate Wester, ESD Field Logistics Associate, JIMAR
- Kaylyn McCoy, ESD Marine Ecosystems Research Coordinator, JIMAR
- Andrew Gray, ESD Marine Ecosystems Research Coordinator, JIMAR
- Rhonda Suka, Optical Mapping Specialist, JIMAR
- Ariel Halperin, ESD Marine Ecosystems Research Technician, JIMAR
- Tomoko Acoba, ESD GIS Specialist, JIMAR
- Rebecca Weible, ESD Marine Debris Field Technician, JIMAR
- Jessica Schem, ESD Marine Debris Field Technician, JIMAR
- Tessa Code, ESD Marine Debris Field Technician, JIMAR
- Kelly Williams, ESD Marine Debris Field Technician, JIMAR
- Andrew McWhirter, ESD Marine Debris Field Technician, JIMAR
- Kristen Kelly, ESD Marine Debris Field Technician, JIMAR
- Michael Pamatat, ESD Marine Debris Field Technician, JIMAR
- Matthew Chauvin, ESD Marine Debris Field Technician, JIMAR
- Steven Gnam, ESD Photographer and Visual Media Specialist, JIMAR
- Josh Levy, UAS Program Coordinator, University of Hawaii Applied Research Lab, UH

Submitted by: O'BRIEN.KEVIN.DAVID. [REDACTED] Digitally signed by
O'BRIEN.KEVIN.DAVID. [REDACTED]
Date: 2019.02.27 12:16:29 -10'00'

Kevin O'Brien
Chief Scientist

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Michael Seki, Ph.D.
Science Director
Pacific Islands Fisheries Science Center

TABLES

Table 1. NOAA Ship *Oscar Elton Sette* project SE-18-05 marine debris daily survey areas, Pearl and Hermes Atoll.

DATE_HST	Location	SURVEY TYPE	Site	Segment	Area (km ²)
9/24/2018	PHR	SWIM	1	1	0.022554
9/24/2018	PHR	SWIM	1	2	0.02267
9/24/2018	PHR	SWIM	1	3	0.029743
9/24/2018	PHR	SWIM	1	1	0.019777
9/24/2018	PHR	SWIM	1	2	0.0283
9/24/2018	PHR	SWIM	1	1	0.033232
9/24/2018	PHR	SWIM	1	2	0.024717
9/24/2018	PHR	SWIM	1	3	0.024049
9/24/2018	PHR	SWIM	1	1	0.017271
9/24/2018	PHR	SWIM	1	2	0.018243
9/24/2018	PHR	SWIM	1	3	0.019439
9/25/2018	PHR	SWIM	1	1	0.016445
9/25/2018	PHR	SWIM	1	1	0.035098
9/25/2018	PHR	SWIM	1	2	0.014271
9/25/2018	PHR	SWIM	1	1	0.04033
9/25/2018	PHR	SWIM	1	2	0.024124
9/25/2018	PHR	SWIM	1	3	0.014302
9/25/2018	PHR	SWIM	1	1	0.033218
9/25/2018	PHR	SWIM	1	2	0.059701
9/26/2018	PHR	SWIM	1	1	0.037376
9/26/2018	PHR	SWIM	1	2	0.04135
9/26/2018	PHR	SWIM	1	1	0.02282
9/26/2018	PHR	SWIM	1	2	0.016276
9/26/2018	PHR	SWIM	2	1	0.005912
9/26/2018	PHR	SWIM	1	1	0.015283
9/26/2018	PHR	SWIM	1	1	0.036906
9/26/2018	PHR	SWIM	2	1	0.0109
9/27/2018	PHR	SWIM	1	1	0.007139
9/27/2018	PHR	SWIM	1	1	0.005884
9/27/2018	PHR	SWIM	2	1	0.019576
9/27/2018	PHR	SWIM	1	1	0.031252
9/27/2018	PHR	SWIM	1	2	0.038856
9/27/2018	PHR	SWIM	1	3	0.010696
9/27/2018	PHR	SWIM	1	3	0.010863
9/27/2018	PHR	SWIM	1	3	0.003391
9/27/2018	PHR	SWIM	1	4	0.001731
9/27/2018	PHR	SWIM	1	1	0.01857

DATE_HST	Location	SURVEY TYPE	Site	Segment	Area (km ²)
9/27/2018	PHR	SWIM	1	2	0.010844
9/28/2018	PHR	SWIM	1	1	0.03679
9/28/2018	PHR	SWIM	1	2	0.008437
9/28/2018	PHR	SWIM	2	1	0.002037
9/28/2018	PHR	SWIM	1	2	0.004254
9/28/2018	PHR	SWIM	1	2	0.040266
9/28/2018	PHR	SWIM	1	1	0.023641
9/28/2018	PHR	SWIM	2	1	0.031784
9/28/2018	PHR	SWIM	1	1	0.063539
9/28/2018	PHR	SWIM	2	1	0.025073
9/28/2018	PHR	SWIM	1	2	0.038645
9/28/2018	PHR	SWIM	1	1	0.003337
9/28/2018	PHR	SWIM	1	1	0.007502
9/28/2018	PHR	SWIM	1	1	0.000245
9/28/2018	PHR	SWIM	1	1	0.002511
9/28/2018	PHR	SWIM	1	1	0.00365
9/29/2018	PHR	SWIM	1	1	0.012056
9/29/2018	PHR	SWIM	1	1	0.025938
9/29/2018	PHR	SWIM	1	1	0.052901
9/29/2018	PHR	SWIM	1	2	0.044587
9/29/2018	PHR	SWIM	1	2	0.001863
9/29/2018	PHR	SWIM	1	1	0.007651
9/29/2018	PHR	SWIM	1	1	0.004172
9/29/2018	PHR	SWIM	1	1	0.017619
9/29/2018	PHR	SWIM	2	1	0.019178
9/29/2018	PHR	SWIM	2	1	0.011299
9/29/2018	PHR	SWIM	1	1	0.014111
9/29/2018	PHR	SWIM	2	1	0.001568
9/30/2018	PHR	SWIM	1	1	0.049989
9/30/2018	PHR	SWIM	2	1	0.012346
9/30/2018	PHR	SWIM	2	1	0.006499
9/30/2018	PHR	SWIM	2	1	0.016871
9/30/2018	PHR	SWIM	1	1	0.021985
9/30/2018	PHR	SWIM	1	2	0.028337
9/30/2018	PHR	SWIM	1	3	0.021354
9/30/2018	PHR	SWIM	1	1	0.01715
9/30/2018	PHR	SWIM	1	2	0.002292
9/30/2018	PHR	SWIM	1	2	0.01238
9/30/2018	PHR	SWIM	1	2	0.009581
9/30/2018	PHR	TOW	1	2	0.069645
9/30/2018	PHR	TOW	1	1	0.040238

DATE_HST	Location	SURVEY TYPE	Site	Segment	Area (km²)
10/1/2018	PHR	SWIM	1	1	0.038388
10/1/2018	PHR	SWIM	1	1	0.009214
10/1/2018	PHR	SWIM	1	2	0.016421
10/1/2018	PHR	TOW	1	1	0.050673
10/1/2018	PHR	TOW	1	2	0.063294
10/1/2018	PHR	TOW	1	3	0.018027
10/1/2018	PHR	SWIM	1	1	0.014389
10/1/2018	PHR	SWIM	1	1	0.011218
10/1/2018	PHR	SWIM	1	1	0.036318
10/1/2018	PHR	SWIM	1	1	0.004343
10/1/2018	PHR	SWIM	1	1	0.002102
10/1/2018	PHR	SWIM	1	2	0.004894
10/1/2018	PHR	SWIM	1	2	0.017593
10/1/2018	PHR	SWIM	1	2	0.016907
10/1/2018	PHR	SWIM	1	3	0.008385
10/1/2018	PHR	SWIM	1	3	0.001174
10/1/2018	PHR	SWIM	1	2	0.0033
10/2/2018	PHR	SWIM	1	1	0.028511
10/2/2018	PHR	SWIM	1	2	0.001617
10/2/2018	PHR	SWIM	1	1	0.009803
10/2/2018	PHR	SWIM	1	1	0.00323
10/2/2018	PHR	SWIM	1	1	0.000601
10/2/2018	PHR	SWIM	1	1	0.019927
10/2/2018	PHR	SWIM	1	2	0.004937
10/2/2018	PHR	SWIM	1	2	0.033461
10/2/2018	PHR	SWIM	1	2	0.006164
10/2/2018	PHR	SWIM	1	2	0.005834
10/2/2018	PHR	SWIM	1	2	0.002941
10/3/2018	PHR	SWIM	1	1	0.026318
10/3/2018	PHR	SWIM	1	2	0.008437
10/3/2018	PHR	SWIM	1	2	0.006752
10/3/2018	PHR	SWIM	1	2	0.00144
10/3/2018	PHR	SWIM	1	2	0.007897
10/3/2018	PHR	SWIM	1	2	0.006664
10/3/2018	PHR	SWIM	1	1	0.032253
10/3/2018	PHR	SWIM	1	1	0.004755
10/3/2018	PHR	SWIM	1	2	0.031449
10/3/2018	PHR	SWIM	1	2	0.003682
10/3/2018	PHR	SWIM	1	2	0.005497

Table 2. Number of surveys conducted by strata for DFG removal sites and control sites.

Strata	Before and after DFG removal sites	Control sites
Zero	6	6
None	4	5
Low	6	5
Chronic	3	5
Acute	2	3

FIGURES

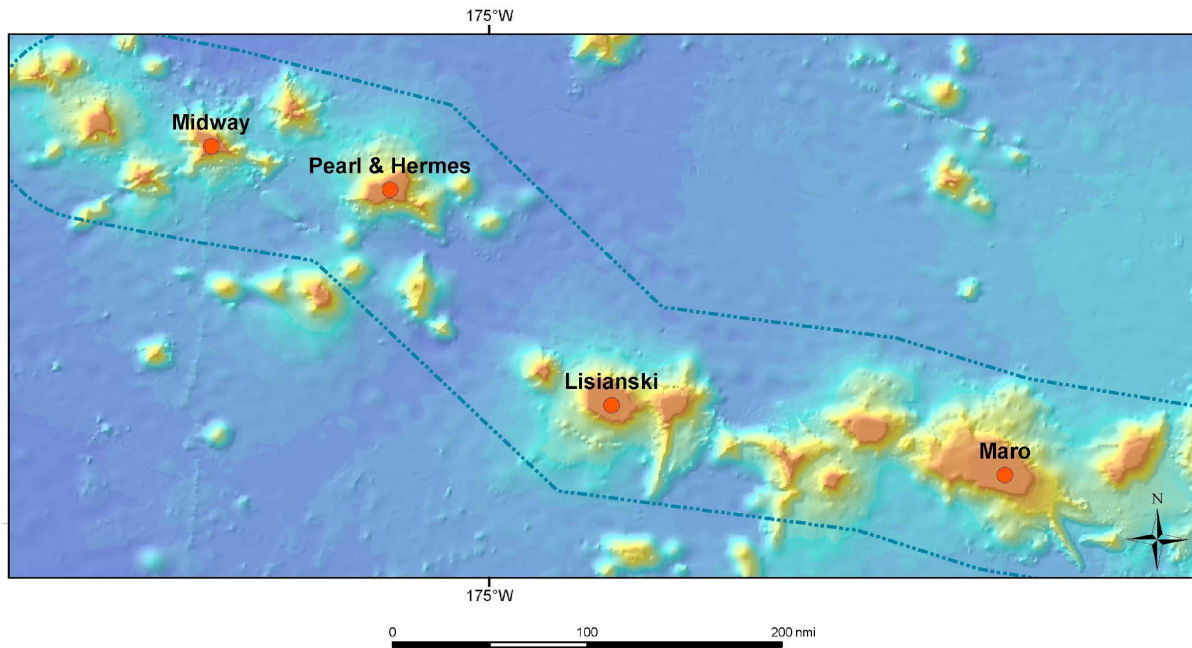


Figure 1. Project operational area for NOAA Ship *Oscar Elton Sette* project SE-18-05.

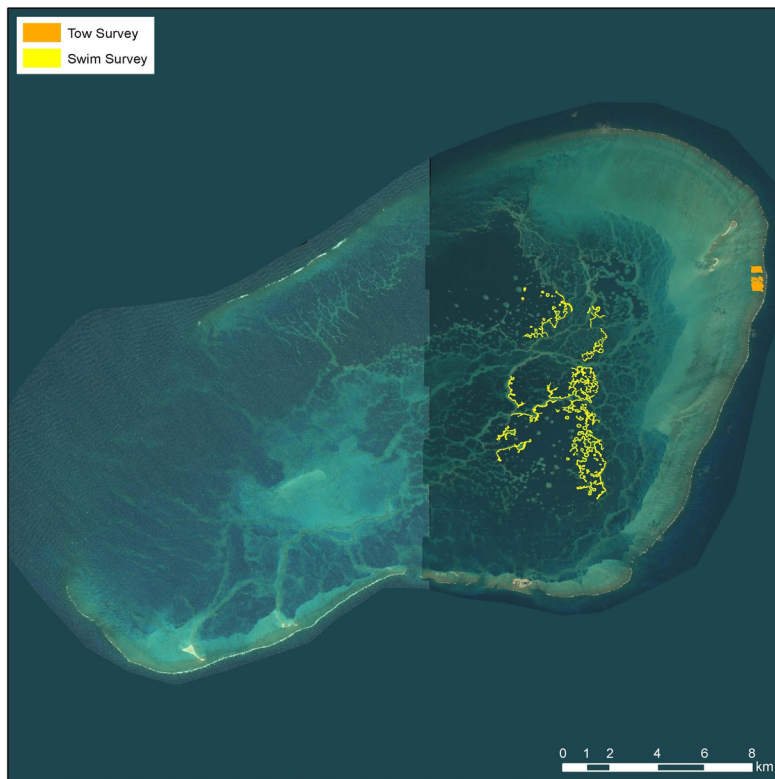


Figure 2. Pearl and Hermes Atoll, wide view, including swim and tow survey areas.

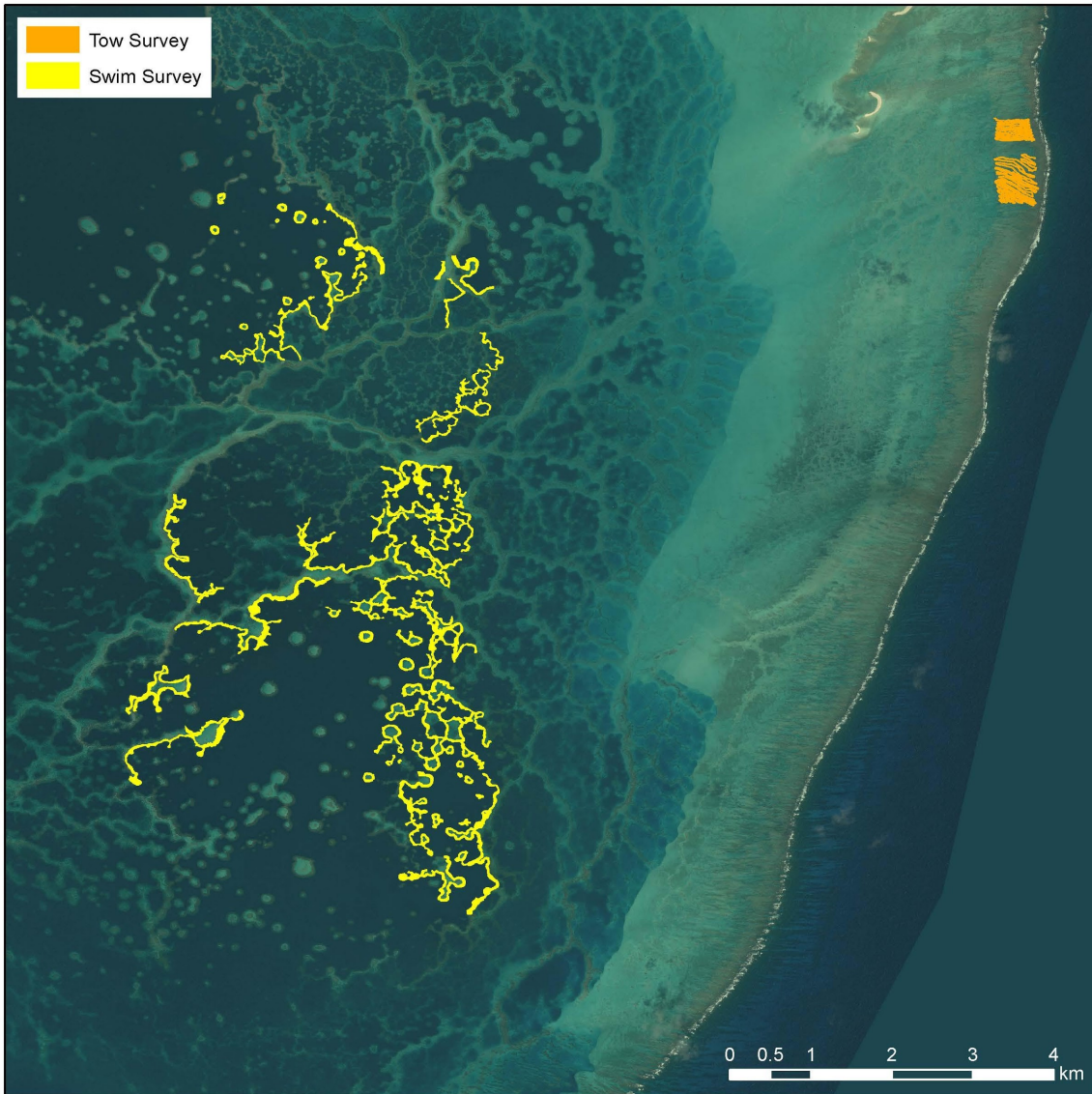


Figure 3. Pearl and Hermes Atoll, zoomed view, including swim and tow survey areas.

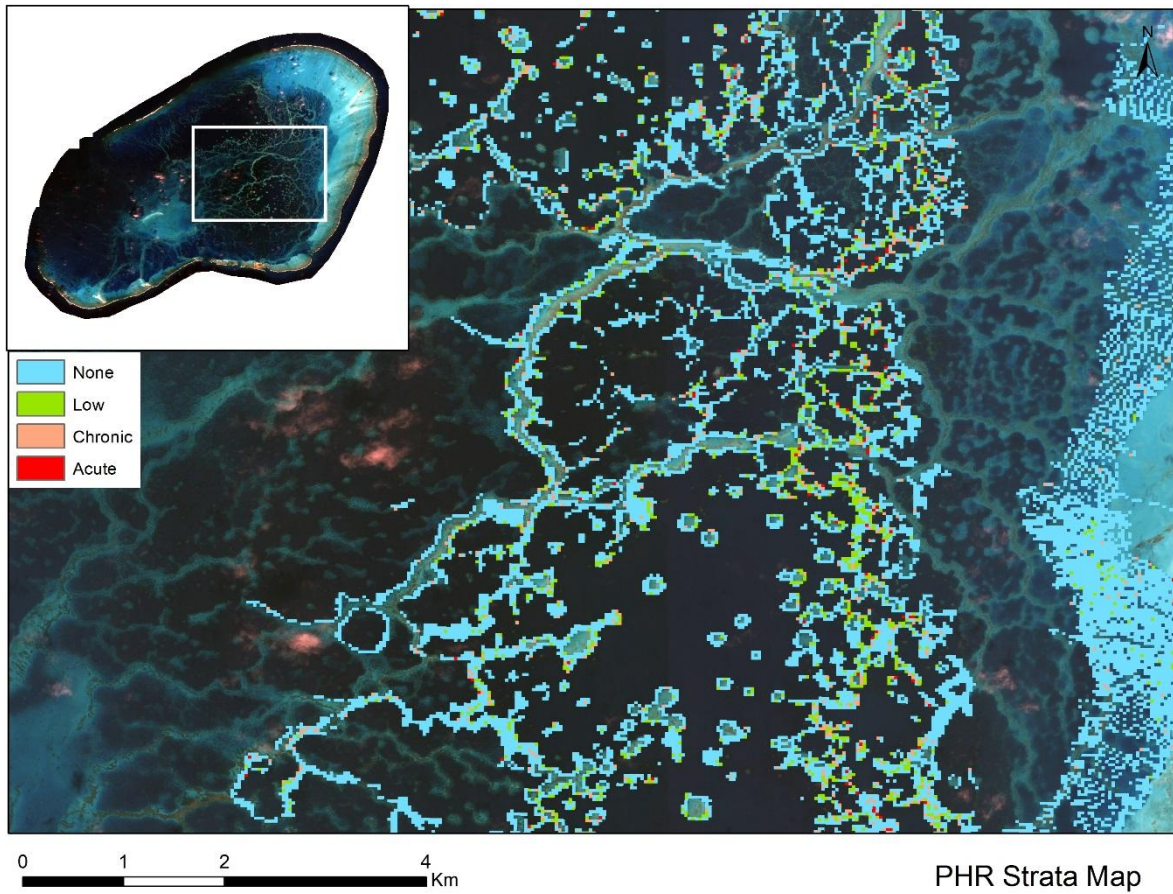


Figure 4. Strata map of Pearl and Hermes Atoll showing 30 meter grid cells colored to indicated density and survey effort per cell.

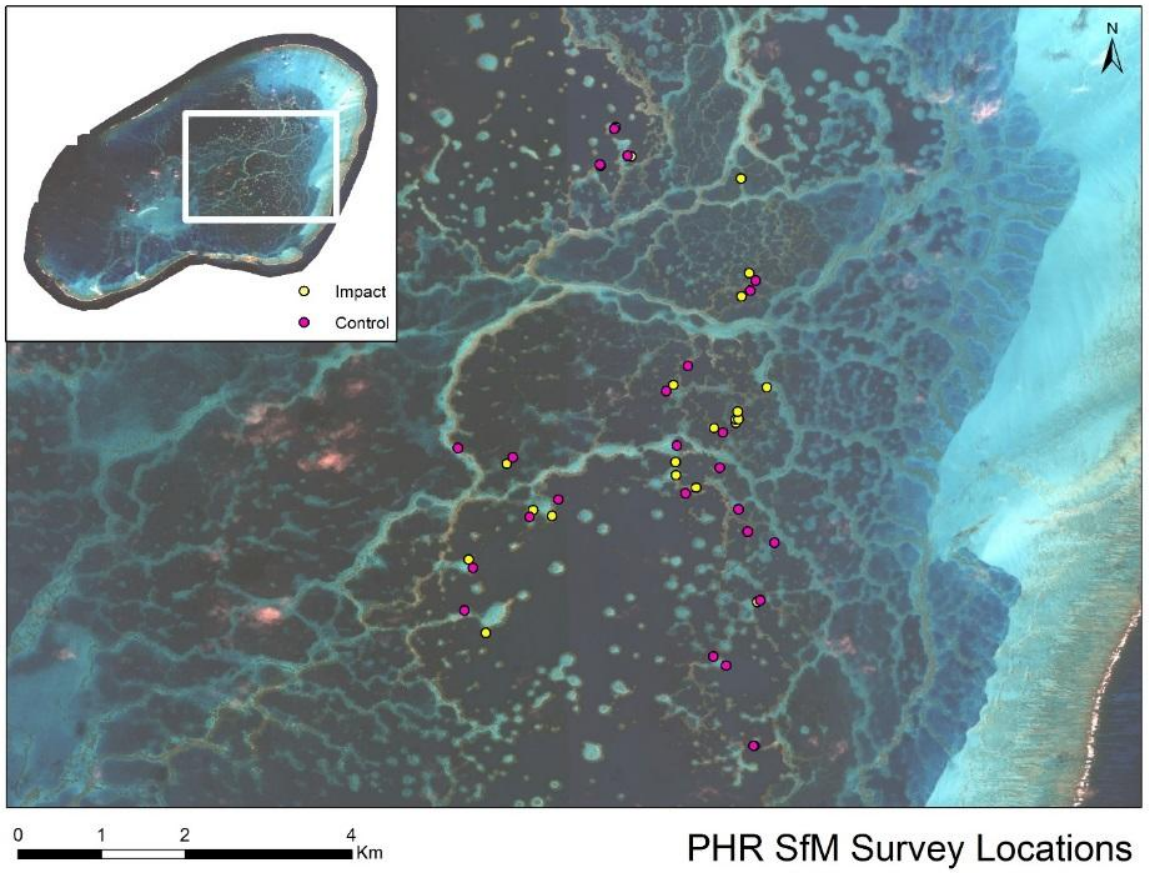


Figure 5. Location of SfM DFG removal sites, shown as yellow points and control sites, shown as pink points.



Figure 6. High-resolution photo mosaics of a DFG removal site before (left) and after (right) removal of nets.



Figure 7. Aerial imagery collected by the Flightwave Edge and RGB+IR payload. DFG is highlighted in red on the left fringing reef edge.

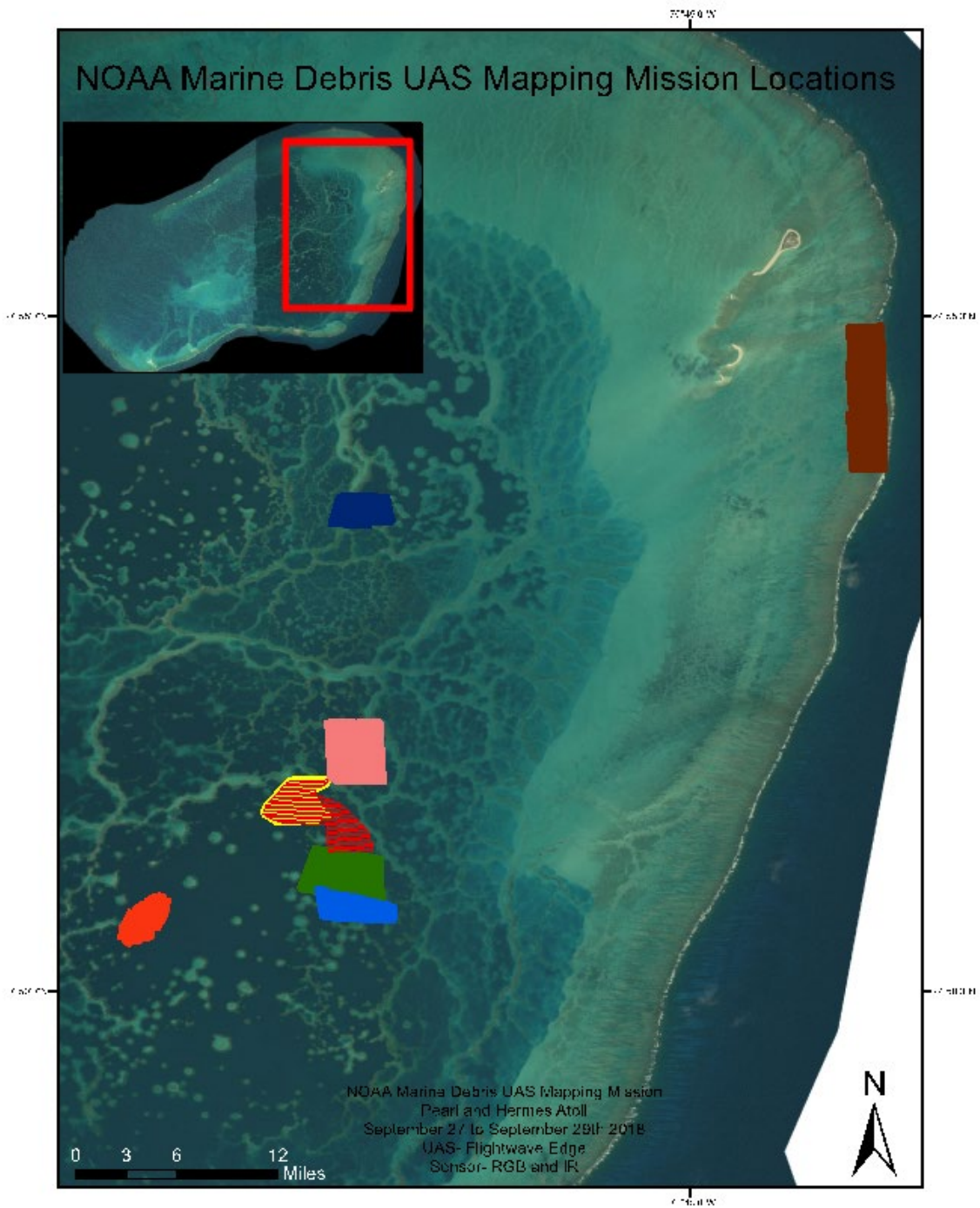


Figure 8. Locations of UAS Operations in Pearl and Hermes Atoll. Different colors indicate individual mapping flights. Note the overlapping yellow and red missions. The yellow mission collected RGB imagery and all other missions collected RGB and IR data.



Figure 9. Satellite tracking buoy locations and initial movements.