National Oceanic & Atmospheric Administration

Shoreline Change Analysis, Sea Turtle Abundance and Marsh Habitat in the Louisiana Barataria Basin Project Summary

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NOAA Report

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Project Summary

I. Overview

A. Project Dates: May 21 – 27, 2023
May 21, 2023 – Depart Pascagoula, MS and drive to Port Fourchon, LA
May 22 – 26, 2023 – LA Field work
May 27, 2023 – Depart Port Fourchon, LA and travel to Pascagoula, MS

B. Operating Area: Barataria Basin, LA primarily near Port Fourchon

C. Objectives:
1. Use uncrewed aircraft systems (UAS) to map shoreline near Port Fourchon jetty for National Ocean Service (NOS) Coast and Shoreline Change Analysis Program (CSCAP).
2. Fly standardized line-transects (at low altitudes) using UAS to document sea turtle presence at the Port Fourchon jetties for the NOAA Fisheries Southeast Fisheries Science Center (SEFSC).
3. Use UAS to map invasive black mangrove and marsh habitat areas for the SEFSC.
4. Map Bayou Lafourche and the western area of Port Fourchon per request of the port.

D. Participating Institutions:
1. NOAA Fisheries, Southeast Fisheries Science Center (SEFSC)
2. NOAA National Ocean Service, National Geodetic Survey, Remote Sensing Division (NOS/RSD)
3. Oceans Unmanned, Inc. (OU)

E. Participants:

Melissa Cook	Biologist/UAS Mission Commander	SEFSC
Jennifer Doerr	Biologist/Vessel Operator	SEFSC
Brian Taggart	UAS Pilot/NOS POC	OU/NOS Affiliate
Matt Pickett	UAS Pilot/NOS POC	OU/NOS Affiliate
Julia Waldsmith	NOS UAS Mission Commander	NOS/RSD

F. Administrative:
1. Point of Contact: Melissa Cook melissa.cook@noaa.gov
Work: 228-549-1668; Mobile: 228-217-6565

2. Permits and Authorizations:
This research conducted under the following permits/authorizations:
- SEFSC Sea Turtle Research Permit No. 21233-04
  - Operate UAS at an altitude no lower than 50 ft (15.2 m)
  - End each encounter within 45 minutes
- UASD NIF #N23-36

II. Equipment

A. Equipment and Capabilities Provided by SEFSC:
   1. Gov to transport equipment & supplies to LA
   2. SwellPro SplashDrone 4 (Splash 4) UAS, sea turtle effigies, station sheets
   3. Vessel and operator for field ops (transported from Galveston, TX to LA)

B. Equipment and Capabilities Provided by NOS/OU:
   1. UAS systems: Quantum Trinity 90+ (Trinity), DJI Matric 30 Thermal (M-30) and UAS operations

III. Field Operations Summary

Field operations were conducted in the Louisiana Barataria Basin, near Port Fourchon (Fig 1). Data were collected for all four objectives (Appendix A). No field days were lost to weather but high winds limited which platforms were flown. Over 11,835 photographs and videos were taken, UAS flew for 11 hrs and 58 min covering ~388 km.

Figure 1. Barataria Basin, LA operation areas. NOS CSCAP working area (blue), SEFSC sea turtle project area along the Port Fourchon jetties (green), SEFSC marsh habitat study area (orange), and the Port Fourchon post-hurricane impact area (red).

NOS Coast and Shoreline Change Analysis Program & NOAA Fisheries Sea Turtle Abundance

Infrastructure development, significant weather events, and sea level change challenge the Remote Sensing Division to collect and interpret imagery products as quickly as possible to ensure that navigational charts representing both man-made and natural features are as accurate as possible. The Coast and Shoreline Change Analysis Program, or CSCAP, specifically targets this mission by assessing satellite and aerial imagery for relevant changes to these critical navigational areas which have the potential to affect the safety of navigation. The Trinity UAS acquired RGB imagery along 64.8 km of flight lines using ground control points along the Port Fourchon coastline and Belle Pass jetties (Fig 2) to explore the use of UAS as an asset to the CSCAP mission. Port Fourchon was chosen as a proof-of-concept test site due to its vulnerability to hurricanes and critical port services supporting industry.

This flight also documented the presence of sea turtles at the Belle Pass jetties (Fig 2), no turtles were observed along the 1.3 km of shoreline, in adjacent waters (~ 0.36 km^2), or in the mouth of the channel. Project time: 10%.

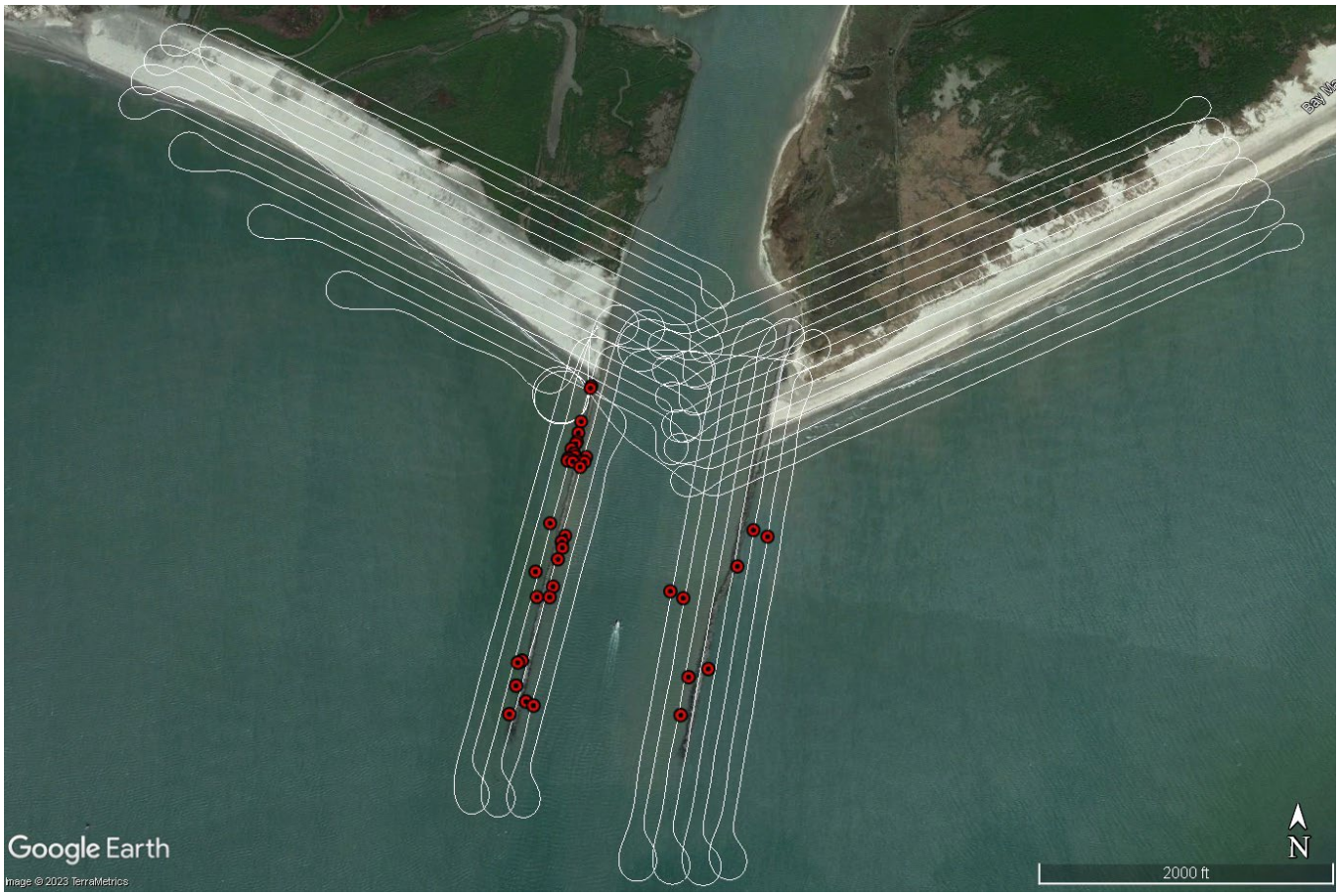

Figure 2. May 22, 2023 Quantum Trinity F90+ track lines (white) and sea turtle (n=40) sightings (red) along the Port Fourchon beach, in the ship channel and along the Belle Pass jetties.

Sea Turtle Presence at the Port Fourchon Jetties

The M-30 was also used to fly standardized line-transects (at 20 m and 30 m) to estimate sea turtle abundance at the Belle Pass jetties and determine most appropriate altitude to observe juvenile sea turtles (< 45 cm SCL). Directed flights using the M-30 and Splash-4 also occurred to photograph sea turtles and sea turtle effigies (See Section IV for more details). Project time: 28.7%.

Marsh Habitat Mapping

The Trinity and M-30 (Fig 3) were used to assess saltmarsh chordgrass, *Spartina alterniflora*, habitat (Fig 4a) which is disappearing due partly to invasive black mangroves, *Avicennia germinans* (Fig 4b). Trinity flights used multiple payloads (LIDAR, 10-band multispectral, and RGB) to determine if various sensors could be used to identify the invasive black mangrove from native salt marsh vegetation. The M-30 was used with RGB (Fig 5a) and thermal payloads (Fig 5b) for the same purpose. It was observed that the invasive black mangroves appear as very dark/black clumps on thermal imagining (Fig 5b). The native live marsh grasses are lighter in color and dead marsh grass appears white. The images collected will also contribute to an updated landscape habitat change analysis currently in progress by SEFSC staff to evaluate temporal changes in habitat cover and composition. Project time: 42%.

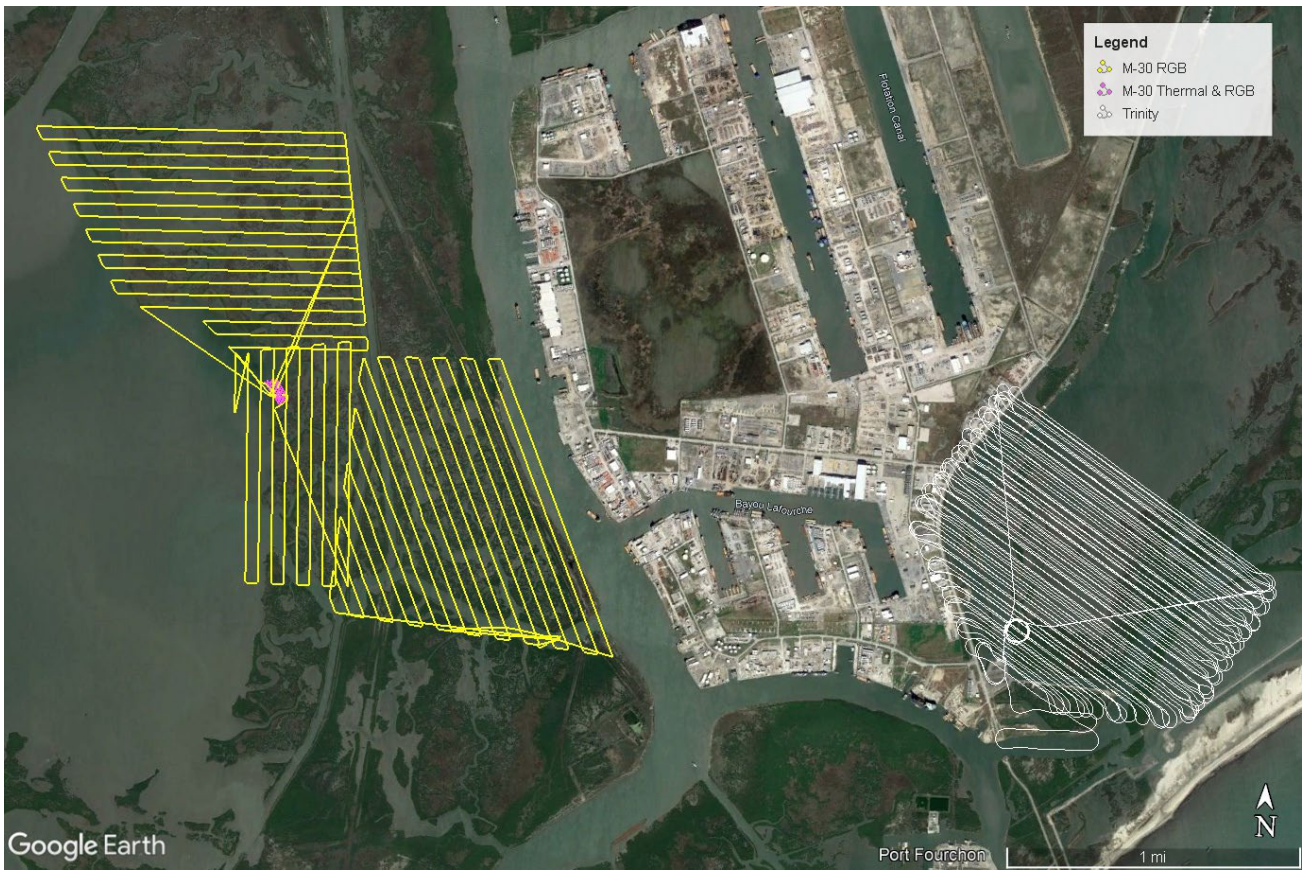

Figure 3. Trinity (white) and M-30 flight paths (yellow and pink) used to map marsh and invasive black mangrove habitat. RGB and thermal payloads were used on flights colored pink.

Figure 4. a) Saltmarsh chordgrass, *Spartina alterniflora*, habitat, b) invasive black mangroves, *Avicennia germinans*.

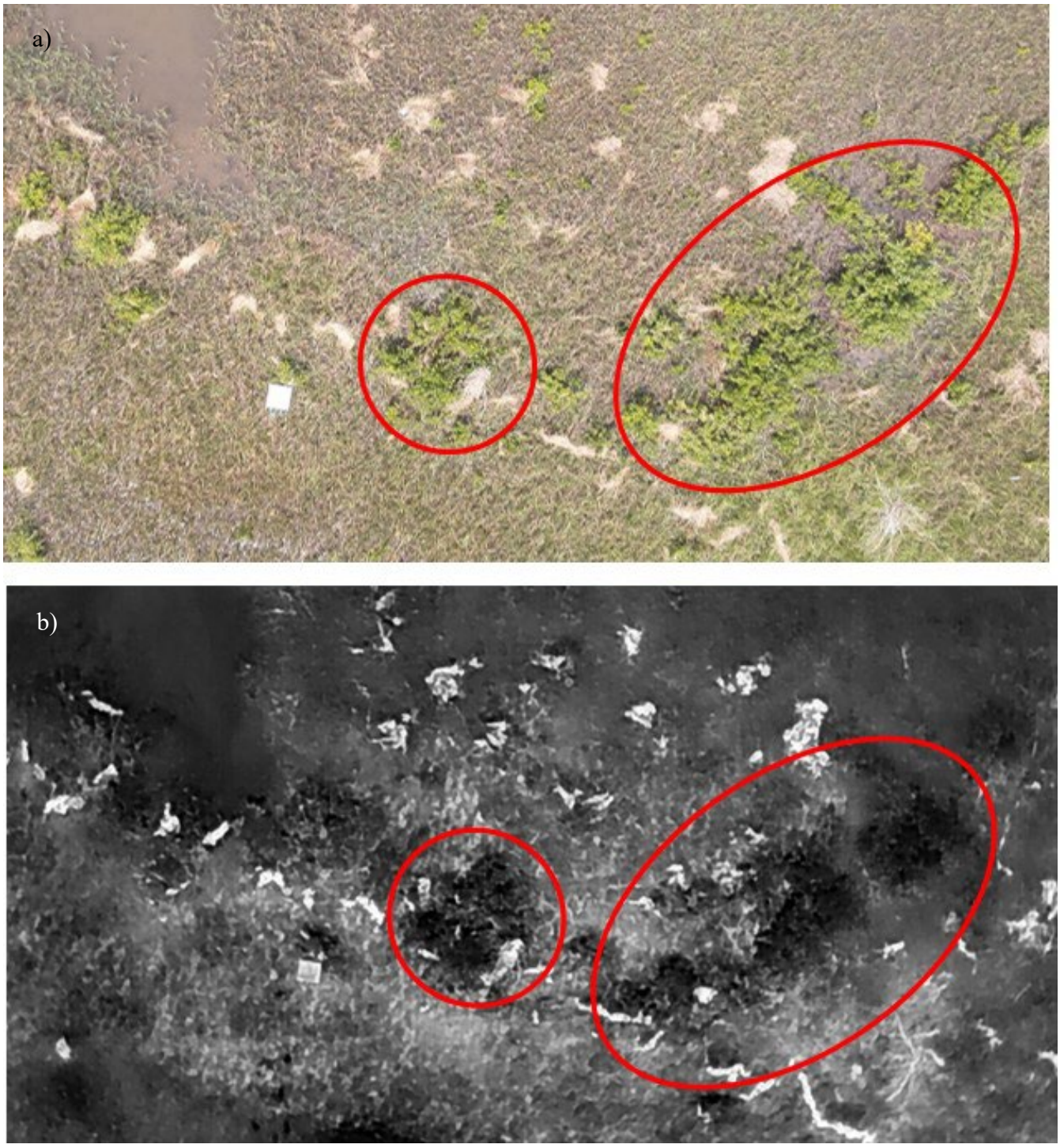

Figure 5. M-30 a) RGB and b) thermal images of saltmarsh habitat. Invasive black mangroves appear as very dark/black clumps (red circles) on thermal imagining, native live marsh grasses are lighter gray, dead marsh grasses are white.

Port Fourchon Mapping

Per request of Port Fourchon, 44.5 km of Bayou Lafourche and the western area of the port was mapped (Fig 6) to provide post-hurricane imaging for impact assessments. Project time: 19.3%.

Figure 6. Bayou Lafourche and the western area of Port Fourchon mapped area (blue).

IV. Results and Discussion of Sea Turtle UAS Flights

An integral part of NOAA's mission involves recovering and conserving protected and endangered species. Measurement of in-water sea turtle abundance was identified as one of the most important data needs for improving sea turtle population assessments and is mandated for NMFS to meet recovery objectives. Traditionally, crewed aerial surveys are used for collecting abundance data, however, they are expensive, time consuming and cannot reliably detect or identify juvenile sea turtles (<45 cm SCL) to species. Globally, UAS are providing an alternative to crewed aerial surveys to collect distribution, abundance, and density data for marine animal populations. UAS are capable of executing line-transect survey patterns and can fly at lower altitudes to increase detection probability of smaller sea turtles.

The objective of this pilot project was to use several UAS platforms to determine if UAS could be used to detect juvenile turtles in nearshore, turbid waters. The area chosen had a known resident population of juvenile green sea turtles documented by in-water work conducted by United States Geological Service

(USGS) and Louisiana Department of Wildlife and Fisheries (LDWF). Live turtles were visually observed by all participants at the surface the morning of May 22 but not seen on subsequent days. The use of the Trinity flown at 120 m and the M-30 and Splash-4 flown between 20 – 40 m were all successful at photographing numerous sea turtles, primarily green sea turtles (*Chelonia mydas*). A total of 6 hrs, 13 min were flown during line transects and directed searches (>109.1 km total, including NOS shoreline mapping). Flights occurred on three days between 9:16 and 16:02. Although the target was to fly during both high and low tide, low tide was at night so most flights were around high tide (Fig 7). Weather was clear, cloud cover ranged from 20 – 60% during all flights and visibility was always greater than three miles. Wind speed greatly varied during the week of operations with several days exceeding the maximum wind speed allowed for operating the Trinity. Although high wind gust warnings (> 11.2 m/s) were observed on the remote control of the M-30, operations were never halted due to wind. Wind speed varied from ~0.2 – 1.7 m/s on May 22 to 8 – 10.3 m/s on both May 24 and May 26. Wave height ranged from 0 – 0.3 m. Water clarity, using a secchi disk, along the jetties on the bayside was 0.63 m, the bottom was visible due to the shallow water depth along the jetties. However, the Port Fourchon channel is 7.3 m deep and 91.4 m wide between the east and west jetties and visibility quickly diminishes off the jetties. Visibility in the channel was 1.05 m during the duration of the project.

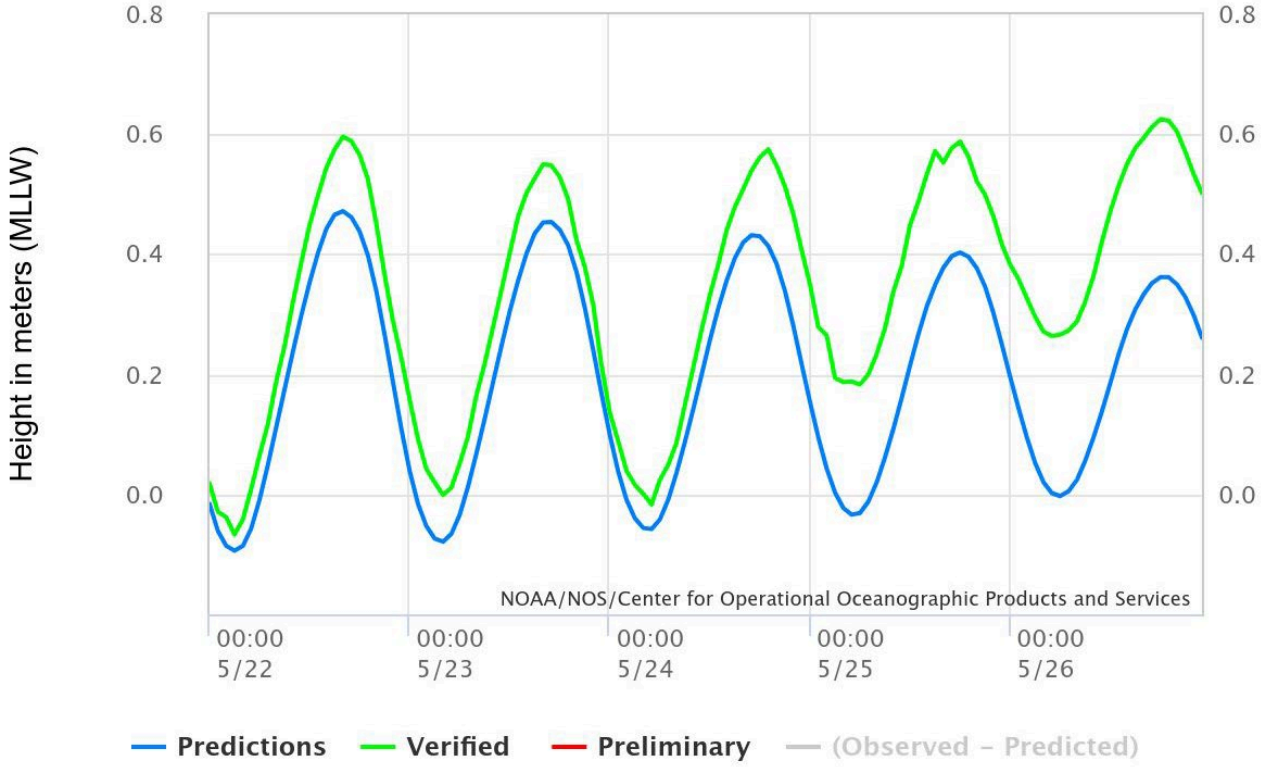

Figure 7. Port Fourchon hourly tidal prediction and verified data from May 22 – 26, 2023.

The Trinity contained a Sony DSC RX1RM2 camera, the M-30 had a CMOS camera and the Splash-4 had a GC3-S 4K/3-axis camera. All RGB cameras were set to automatic settings consisting of automatic white balance, ISO 100, F-stop 2.5, automatic shutter speed, and no filters were used. During line-transect surveys, the camera angle was set to 90 degrees (nadir), front overlap varied from 60 – 70% and

side overlap varied from 10 – 75% depending on project focus. The Trinity collected 1,885 images, the M-30 collected 2,825 images, and the Splash-4 collected 46 images and 17 videos.

All Trinity and M-30 photographs (4,710) were reviewed for the presence of turtles; 1 – 4 turtles were observed on a single image (Trinity=73, M-30=54), and 127 images contained 136 possible turtles. A second reviewer independently reviewed all possible turtle images to confirm presence and species identification. The high percentage of front and side overlap, resulted in multiple images of the same individual (Fig 8 a, b). Therefore, photographs were reviewed again to estimate the actual number of turtles present (Table 1) during each flight.

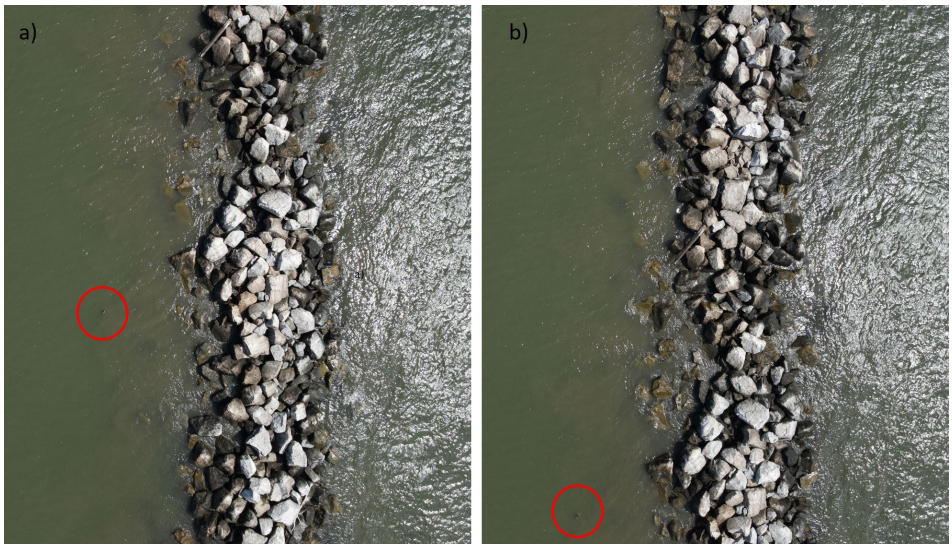

Figure 8. Consecutive photographs (a, b) of the same green sea turtle (*Chelonia mydas*) in the western bay by the Port Fourchon Belle Pass Channel jetty.

Table 1. Estimated number of individual sea turtles observed on Trinity and M-30 flights in the bay and Port Fourchon Belle Pass Channel.

Date, Platform & Species	W. Bay	W. Channel	E. Bay	E. Channel	**Total**
5/22/2023					**60**
Trinity	**19**	**13**	**4**	**4**	**40**
Cheloniidae	3	3		2	8
Green	16	10	4	2	32
M-30	**8**	**12**			**20**
Cheloniidae	2				2
Green	6	12			18
5/24/2023					**5**
M-30	3		1	1	5
Cheloniidae			1		1
Green	3			1	4
5/26/2023					**3**
M-30	2		1		**3**
Cheloniidae			1		1
Green	1				1
Kemp's ridley	1				1
Total	**32**	**25**	**6**	**5**	**68**

The most turtles (88.2%; 60/68) were observed on the first day of operations which also had the best conditions, very little wind or waves, although turtles were photographed on all three days in both the bay and Bell Pass Channel (Fig 9). The majority of turtles (58.8%; 40/68) were observed during the 61-minute Trinity flight occurring from 11:57 – 12:58 which coincided with high tide (0.59 m). The western bay and western channel side of the jetties had substantially more (80.0%, 32/40) turtles than the eastern bay and channel (20.0%, 8/40). Subsequent M-30 line transect and directed search flights, along the west jetty, from 13:20 – 15:33 observed 20 additional turtles; time did not allow for flights on the eastern jetty. The tide was falling, ranging from 0.55 to 0.37 m by the end of the flight.

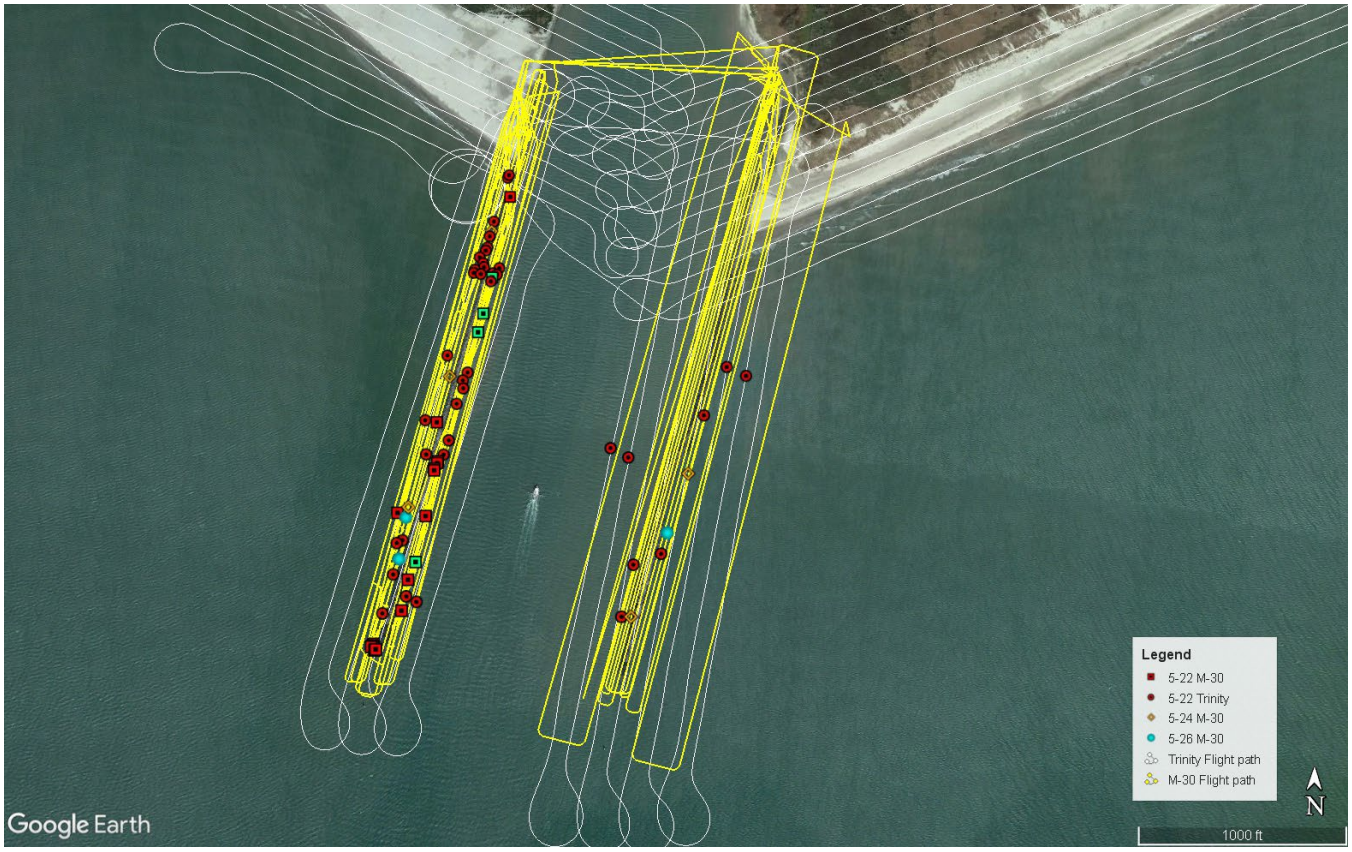

Figure 9. Flight paths of Trinity (white) and M-30 (yellow) flights from May 22, 24, and 26, 2023 along the Port Fourchon Belle Pass Channel jetties and sea turtles (n=68) documented (red square, red circle, yellow diamond, blue circle) each day.

Although flights on May 24 (10:18 – 12:14) and May 26 (9:16 – 10:09) provided ample coverage of both jetties, 15.4 km and 7.9 km, respectively, only a total of 8 turtles were observed (Fig. 10 a, b). Compared to May 22, flight times were earlier, morning flights verses afternoon. The tide was rising both mornings, and varied from 0.48 to 0.58 m. Wave height was 0.2 – 0.3 m as compared to 0 m on the 22nd. Wind speed was also greatly increased, varying from ~8 – 10 m/s with much higher gusts. These factors could have made it more difficult to observe turtles in photographs. Ripples on the surface and glare make it very difficult to detect turtles that are underwater. Although, having multiple sequential images helps with detection.

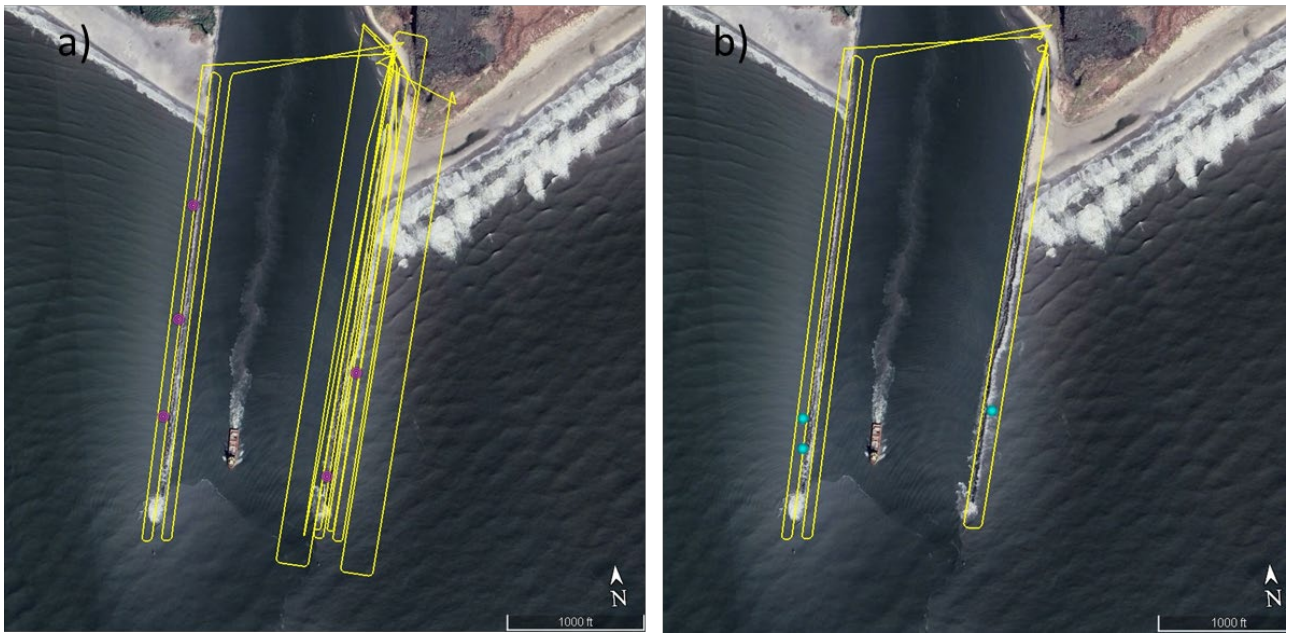

Figure 10. M-30 flight paths and sea turtles observed near the Port Fourchon Belle Pass Channel jetties. a) May 24, 2023 flight path and sea turtles (n=5), b) May 26, 2026 flight path and sea turtles (n=3).

The majority (80.9%; 55/68) of sea turtles were small, green sea turtles seen taking a breath at the surface or underwater (Fig 11 a, b). One Kemp's ridley was identified and the remaining 12 turtles (17.6%) were classified as Cheloniidae because it was too difficult to determine species. Turtles did not appear to remain at the surface long as an entire breath sequence (3 – 5 seconds) could be seen on 3 – 4 consecutive images. Turtles remained fairly close to the jetties, only two turtles were further into the shipping channel. During operations, we observed high amounts of shipping traffic, which may be why turtles avoided the channel. During our surveys (Fig 9), 83.8% (57/68) of turtles were found on the western side, of those 56.1% (32/57) were located in the western bay and 43.9% (25/57) were located in the western Belle Pass Channel. Only 16.2% (11/68) of turtles were found on the eastern side; nearly equal numbers were in the channel (5/11) and the bay (6/11).

Our UAS image results supported previous USGS in-water dip net capture-mark-recapture efforts conducted at this site every May and December from 2014 to 2019. The USGS captured 95.7% (155/162) of turtles on the western side and only 4.3% (7/162) on the eastern side. Although the USGS captured fewer turtles in the western channel, 94.2% (146/155) were captured in the western bay and only 5.8% (9/155) were captured in the western shipping channel. USGS effort was concentrated along the bay side of the west jetty due to prevailing winds and weather during sampling events, along with heavy boat traffic on the inside of the channel, and active construction of the Caminada Headlands Beach and Dune Restoration project on the bay side of the east jetty.

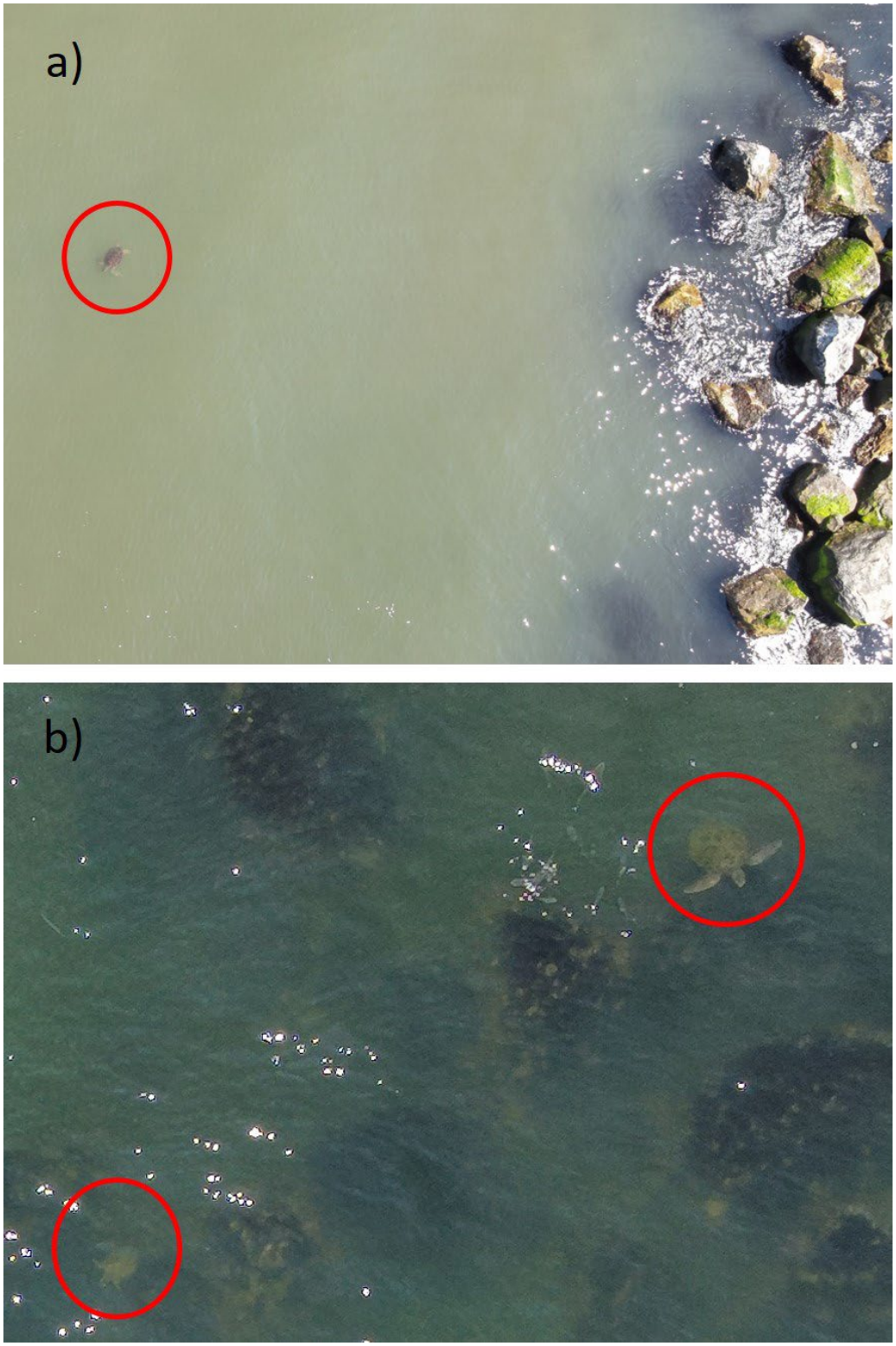

Figure 11. Drone images of green sea turtles (red circle) a) just off the jetty in the Port Fourchon shipping channel, b) two green sea turtles just off the southern end of the western jetty.

Size Estimates

Size estimates were only possible during the manual flights conducted using the M-30 because that was the only platform with a laser altimeter which is required for accurate measurements. The sea turtle effigies were also photographed at different altitudes and in two locations. All images were reviewed by two independent reviewers. ImageJ software was used to measure the sea turtles and effigies (Appendix B).

Four of the wild green sea turtles photographed were measured (Fig 11a). The average size was 36.7 cm SCL (range 31.1 – 48.2 cm) which is within the size range of USGS captured green turtles (25.6 – 44.2 cm SCL) (K. Hart, USGS and LDWF unpublished data 2022). Reader size estimates were similar with SCL differences ranging from 0.3 – 1.4 cm between readers for the live turtles. The effigies were measured on a dock and in the water. Measuring the effigies on the dock allowed for the comparison without the interference of water currents and since all objects, including the UAS, were on the same plane it allowed for the most accurate measurement possible. Reader size estimates for effigies at various altitudes were fairly similar, varying no more than 3.2 cm. The estimates of the effigies on the dock were closer to the actual value than the estimates of the effigies in the water.

The largest differences from the actual values for the same effigy were 7.3 and 8.0 cm smaller due to the angle of the turtle in the water caused by the current (Fig 12). However, this is a typical angle observed by wild turtles surfacing to breathe. Therefore, we measured the effigies straight carapace width (SCW) to see if that provided a more accurate estimate then SCL. Although only 15 measurements were available, SCW measurements were closer to actual values varying by an average of 4.6% and differences of only 0 to 2.8 cm. While SCL measurements varied by an average of 9.8% and 0.1 to 7.3 cm. Since we do not know the actual size of turtles in the wild, it is recommended to use multiple reviewers, measure SCL and SCW, and average the size estimates to obtain the best estimate.

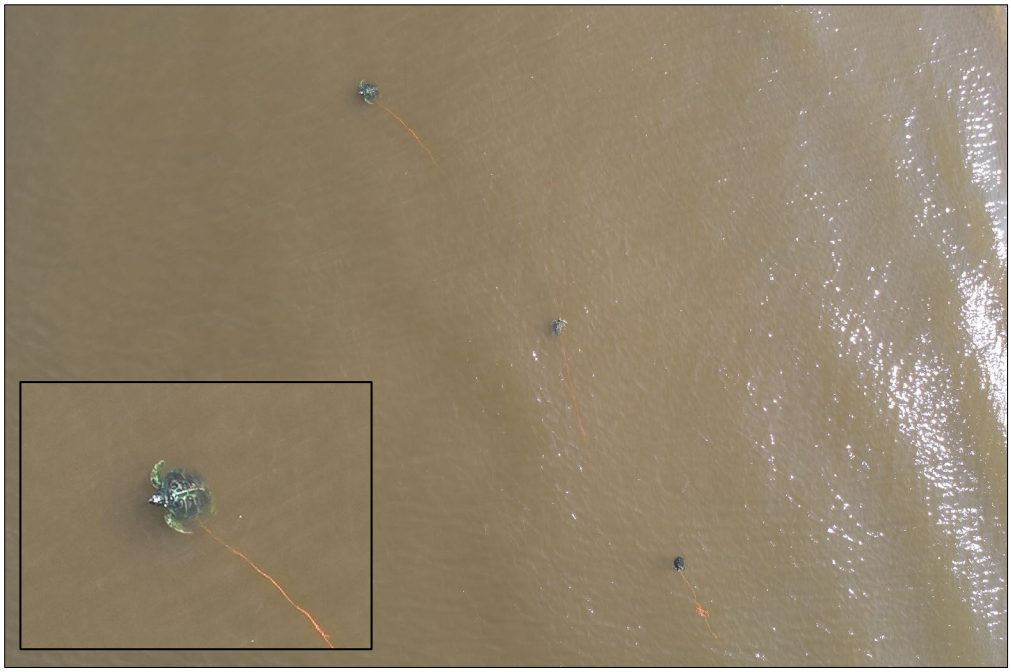

Figure 12. Sea turtle effigies photographed at 14.1 m altitude. Insert shows the angle of the top effigy.

Lessons Learned

The use of multiple UAS platforms should be considered when planning a project, especially due to varying environmental field conditions (i.e. wind). Wind, waves and sun glare are the largest factors influencing turtle detection during directed flights and on images during post-processing. Taking pictures with 60 – 70% front overlap made detecting turtles underwater and during suboptimal conditions easier, since turtles could be observed in sequential images. However, if abundance estimates are an objective, total count corrections will need to occur due to multiple images of the same individuals. The amount of side overlap needs to be considered and farther evaluated to ensure that double counts are not occurring. For example, Figure 13 shows a block of photograph locations taken over ten minutes of transect time, covering over 30,000 m^2. The area contains 34 photographs, 14 photographs with turtles present, totaling 36 turtles. However, both front and side overlap, require correcting for the actual number of individuals. Front overlap corrections resulted in an estimate of 13 turtles during that 10-minute flight time. Due to the time delay between adjacent images, correcting for side overlap is much more challenging. A new turtle could come into the area, the same individual could be photographed again, a counted turtle could move and be recounted, or a submerged turtle surfaces.

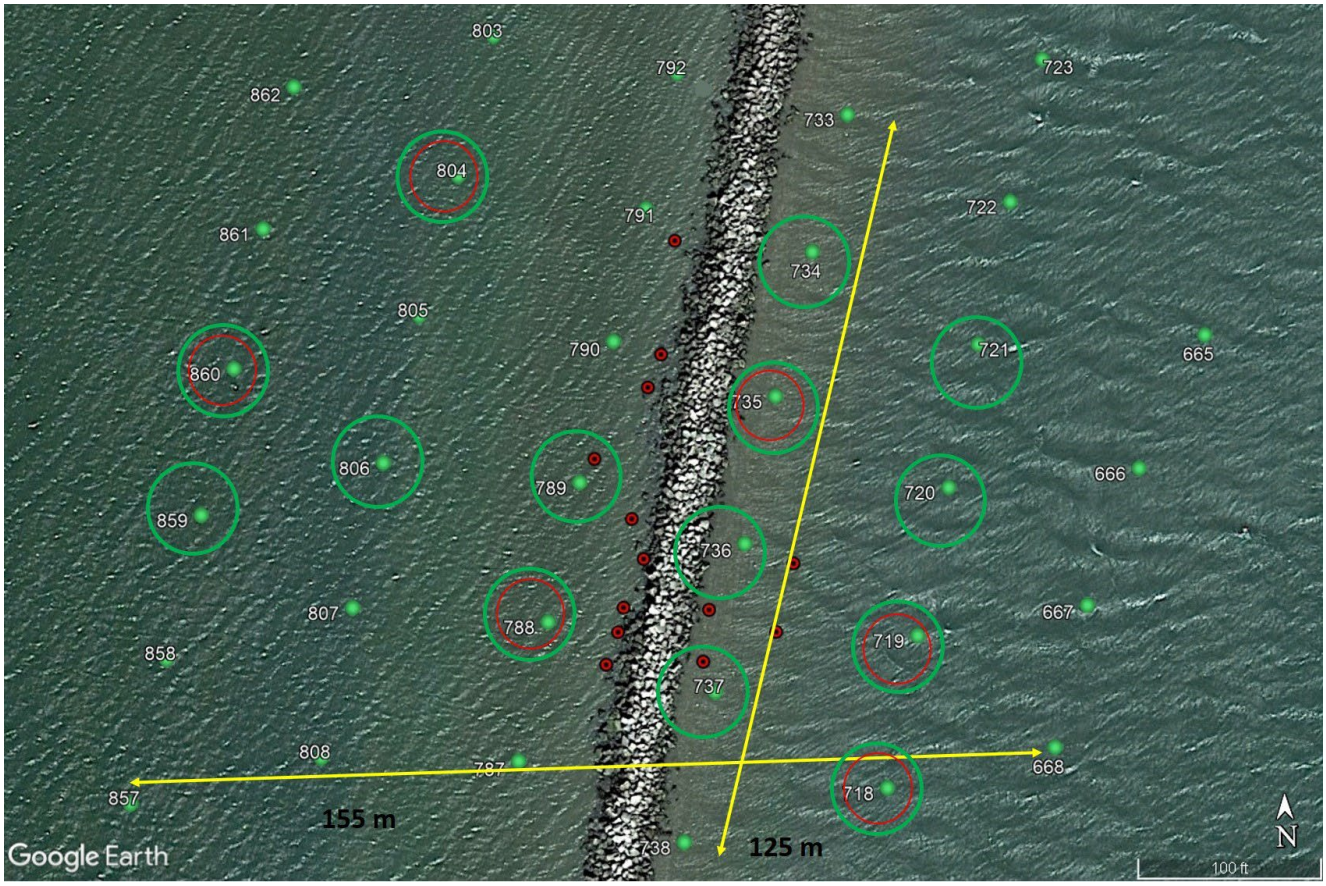

Figure 13. Block of photograph locations (green dots) taken along the Port Fourchon jetties on May 22, 2023 from 12:15:31 to 12:25:27. Photographs containing sea turtles (n=14) are circled in green. Photographs (n=6) with estimated actual number of sea turtles present are circled (red). Red dots are estimated actual number of sea turtles (n=13) and their location.

Figure 14 shows multiple photographs of the jetty and turtles present (yellow circles) on five transects flown by the Trinity on May 22, 2023 (Fig 13). The photographs were taken over a five-minute period along ~100 m of jetty. Picture 718 shows 4 turtles, two in the channel and two in the bay. The next image, 735, shows three turtles in the bay. This image is much further north than the previous picture so these are assumed to be new turtles. Therefore, 7 turtles present so far. There is a blue bucket (blue circle) on the jetty that is in image 735, 788 and 804 and can be used as a reference point. Image 788 has two turtles in the bay and two turtles in the channel. The channel turtles were not in the previous pictures and are counted as new individuals. Two of the turtles are in the same vicinity of the bucket in both in 735 and 788. The pictures were taken 90 seconds apart so it is possible they are the same turtles but could also be new turtles. Image 804 also has a turtle in the bay near the same blue bucket and finally image 860 has a new turtle due to its distance from the jetty. Even with careful evaluations it is difficult to determine if there are 10 or 13 turtles in the area. The jetty provided a barrier that made determining new turtles from resightings a bit easier. However, barriers are typically not present during sea turtle surveys. Removing any side overlap or even having space between transect lines would greatly reduce the possibility of double counting.

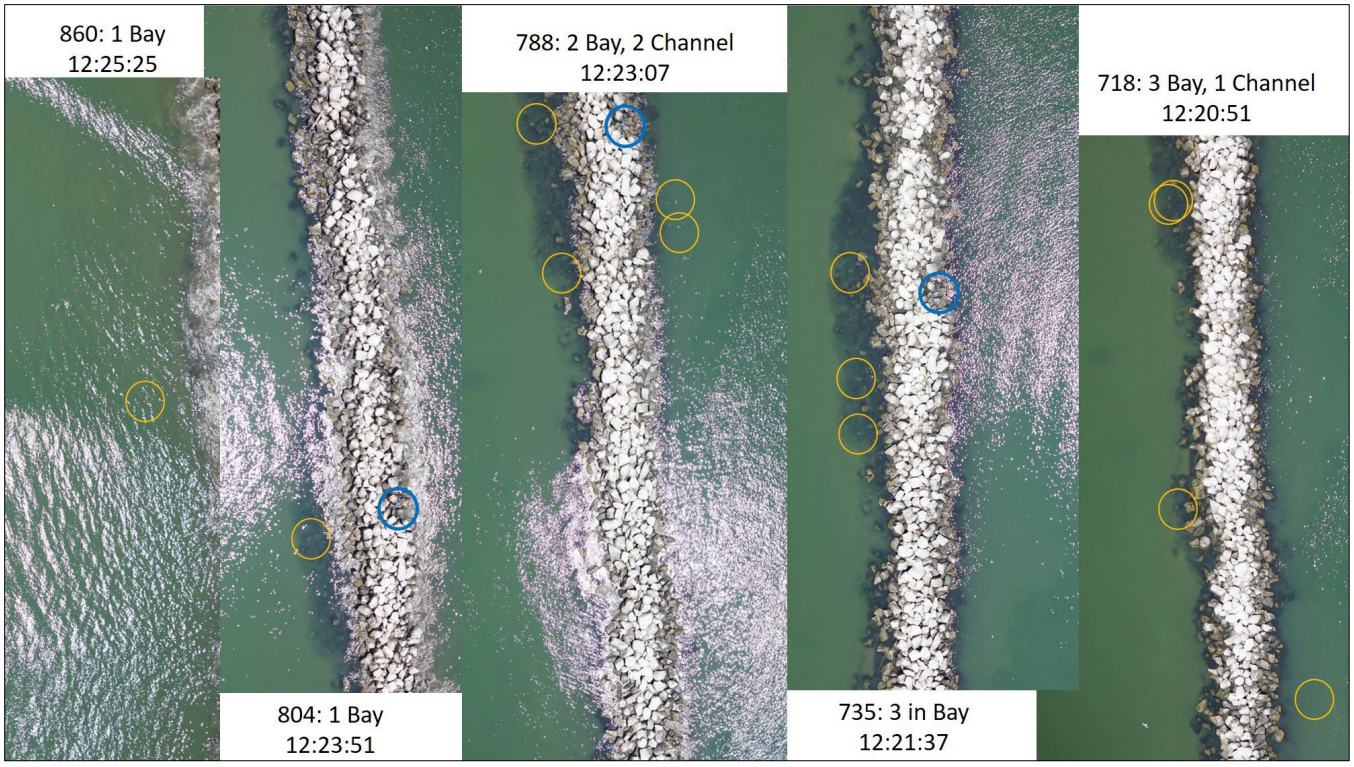

Figure 14. Sequential photographs from right to left of ~100 m of the Port Fourchon jetty. Yellow circles are turtles. Blue circle is a bucket that is observed in three photographs and used as a location reference point.

In conclusion, the use of UAS shows great promise to supplement and enhance current in-water abundance estimates. There are still challenges to overcome and determining the best practices to ensure repeatability is essential. Other challenges include the significant amount of time involved reviewing the

UAS photographs and estimating the number of turtles present. A three-year joint project between the SEFSC and SWFSC called, “Estimating green turtle abundance at two U.S. foraging sites and establishing best practices for UAS-based marine turtle monitoring, aims to tackle the challenges of post-processing by evaluating different tools and workflows for analyzing survey data and determine the best practices to use for UAS-based sea turtle monitoring in the future.

Appendix A. Uncrewed systems flight operations in the Barataria Basin from May 22 – 26, 2023.

Date	Flight No	Mission	Platform	Payload	Alt (m)	Takeoff	Landing	Flight time	Distance (km)
5/22/2023	1	NOS shoreline mapping and SEFSC sea turtle abundance	Quantum Trinity 90+	RGB Camera	120	11:57	12:58	1:01	64.80
5/22/2023	1	SEFSC sea turtle abundance	DJI M30T	RGB Camera	20	13:20	13:53	0:33	1.99
5/22/2023	2	SEFSC sea turtle abundance	DJI M30T	RGB Camera	20	13:54	14:15	0:21	2.11
5/22/2023	3	SEFSC sea turtle abundance	DJI M30T	RGB Camera	30	14:26	14:55	0:29	4.91
5/22/2023	4	SEFSC sea turtle abundance	DJI M30T	RGB Camera	15.2	15:07	15:33	0:26	2.42
5/22/2023	5	SEFSC sea turtle abundance	DJI M30T	RGB Camera	15	15:36	16:02	0:26	3.96
5/23/2023	1	SEFSC Mangrove habitat mapping	Quantum Trinity 90+	LIDAR	120	11:25	12:05	0:40	43.40
5/23/2023	2	SEFSC Mangrove habitat mapping	Quantum Trinity 90+	10-Band multispectral	120	12:32	13:30	0:58	59.80
5/23/2023	3	SEFSC Mangrove habitat mapping	Quantum Trinity 90+	RGB Camera	120	13:35	14:32	0:57	53.00
5/24/2023	1	SEFSC sea turtle abundance	DJI M30T	RGB Camera	30	10:18	10:38	0:20	5.17
5/24/2023	2	SEFSC sea turtle abundance	DJI M30T	RGB Camera	30	10:50	11:12	0:22	5.40
5/24/2023	3	SEFSC sea turtle abundance	DJI M30T	RGB Camera	30	11:25	11:48	0:23	6.45
5/24/2023	4	SEFSC sea turtle abundance	DJI M30T	RGB Camera	20	11:57	12:14	0:17	4.00
5/24/2023	1	SEFSC sea turtle abundance	SwellPro Splash4	RGB Camera		12:38	12:58	0:20	
5/24/2023	2	SEFSC sea turtle abundance	SwellPro Splash4	RGB Camera		13:03	13:20	0:17	
5/24/2023	3	SEFSC sea turtle abundance	SwellPro Splash4	RGB Camera		13:28	13:42	0:14	
5/24/2023	4	SEFSC sea turtle abundance	SwellPro Splash4	RGB Camera		13:42	13:45	0:03	
5/25/2023	1	SEFSC Mangrove habitat mapping	DJI M30T	RGB Camera	120	12:29	12:45	0:16	11.00
5/25/2023	2	SEFSC Mangrove habitat mapping	DJI M30T	RGB Camera & Thermal	120	12:47	13:02	0:15	19.23
5/25/2023	3	SEFSC Mangrove habitat mapping	DJI M30T	RGB Camera	120	13:03	13:16	0:13	1.28
5/25/2023	1	SEFSC Mangrove habitat mapping	DJI M30T	RGB Camera		17:16	17:31	0:15	9.90
5/25/2023	2	Port Fourchon mapping	DJI M30T	RGB Camera	120	17:49	18:06	0:17	11.50
5/25/2023	1	Port Fourchon mapping	DJI M30T	RGB Camera	120	9:16	9:28	0:12	2.28
5/26/2023	1	SEFSC sea turtle abundance	DJI M30T	RGB Camera	varied	9:16	9:28	0:12	

Date	Flight No	Mission	Platform	Payload	Alt (m)	Takeoff	Landing	Flight time	Distance (km)
5/26/2023	2	SEFSC sea turtle abundance	DJI M30T	RGB Camera	30	9:31	9:40	0:09	2.64
5/26/2023	3	SEFSC sea turtle abundance	DJI M30T	RGB Camera	20 & 30	9:49	10:09	0:20	5.26
5/26/2023	1	SEFSC Mangrove habitat mapping	DJI M30T	RGB Camera	120	10:53	11:14	0:21	14.40
5/26/2023	2	SEFSC Mangrove habitat mapping	DJI M30T	RGB Camera	120	11:18	11:41	0:23	15.40
5/26/2023	3	SEFSC Mangrove habitat mapping	DJI M30T	RGB Camera	120	11:42	12:05	0:23	15.40
5/26/2023	1	Port Fourchon mapping	DJI M30T	RGB Camera	120	15:17	15:37	0:20	12.90
5/26/2023	2	Port Fourchon mapping	DJI M30T	RGB Camera	120	15:47	16:02	0:15	10.20

Appendix B. Results of wild green sea turtle measurements and sea turtle effigy measurements. Effigies were measured on a floating dock and in the water at various altitudes. SCL=straight carapace length; ⎪Ave-Actual⎪ is the absolute value of the average SCL minus the actual SCL.

Photo Name & Location	Object ID	Reader 1 SCL (cm)	Reader 2 SCL (cm)	Ave SCL (cm)	⎪Ave - Actual⎪ SCL (cm)
DJI_20230522134943_0017_W	Cm_20230522134943_0017	33.7	34.2	34.0	
DJI_20230522135715_0020_W	Cm_20230522135715_0020	47.5	48.9	48.2	
DJI_20230522135758_0022_W	Cm_20230522135758_0022	31.6	30.6	31.1	
DJI_20230522135904_0025_W	Cm_20230522135904_0025	33.7	33.4	33.6	
DJI_20230525115347_0024 On the dock 15.4 m	Sm turtle effigy - 24.3 cm	26.8	26.0	26.4	2.1
	Med turtle effigy - 34.2 cm	36.2	36.2	36.2	2.0
	Lg turtle effigy - 38.0 cm	40.6	42.0	41.3	3.3
DJI_20230525115333_0020 On the dock 20.2 m	Sm turtle effigy - 24.3 cm	25.7	25.8	25.8	1.5
	Med turtle effigy - 34.2 cm	34.2	35.5	34.9	0.6
	Lg turtle effigy - 38.0 cm	38.2	41.4	39.8	1.8
DJI_20230525115311_0016_W On the dock 30.1 m	Sm turtle effigy - 24.3 cm	26.3	25.3	25.8	1.5
	Med turtle effigy - 34.2 cm	33.9	34.3	34.1	0.1
	Lg turtle effigy - 38.0 cm	41.8	41.9	41.9	3.9
DJI_20230525115245_0013 On the dock 39.8 m	Sm turtle effigy - 24.3 cm	25.4	26.6	26.0	1.7
	Med turtle effigy - 34.2 cm	33.3	32.8	33.1	1.2
	Lg turtle effigy - 38.0 cm	40.2	42.5	41.4	3.3
DJI_20230526072524_0003 In water 14.1 m	Sm turtle effigy - 24.3 cm	22.1	22.6	22.4	2.0
	Med turtle effigy - 34.2 cm	28.5	29.4	29.0	5.3
	Lg turtle effigy - 38.0 cm	30.7	30.0	30.4	7.7
DJI_20230526072544_0007 In water 18.7 m	Sm turtle effigy - 24.3 cm	24.4	22.6	23.5	0.8
	Med turtle effigy - 34.2 cm	33.4	32.6	33.0	1.2
	Lg turtle effigy - 38.0 cm	34.5	33.1	33.8	4.2
DJI_20230526071609_0001 In water 20.5 m	Sm turtle effigy - 24.3 cm	25.1	23.9	24.5	0.2
	Med turtle effigy - 34.2 cm	28.6	30.7	29.7	4.6
	Lg turtle effigy - 38.0 cm	38.8	38.3	38.6	0.6
DJI_20230526072605_0008 In water 28.8 m	Sm turtle effigy - 24.3 cm	25.1	23.6	24.4	0.0
	Med turtle effigy - 34.2 cm	30.4	28.9	29.7	4.6
	Lg turtle effigy - 38.0 cm	32.8	30.9	31.9	6.2
DJI_20230526072635_0013 In water 38.7 m	Sm turtle effigy - 24.3 cm	25.5	23.0	24.3	0.1
	Med turtle effigy - 34.2 cm	27.4	28.1	27.8	6.5
	Lg turtle effigy - 38.0 cm	32.2	32.2	32.2	5.8