Analysis of Feeding Trails Provides Evidence of the Number of Dugongs Excavating Seagrass at Key Habitats Seasonally in the Egyptian Red Sea

Final Report to Rufford Foundation

The Rufford Foundation

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Acknowledgements

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1. Introduction

Dugongs (*Dugong dugon*) or the sea cows are herbivorous marine mammals found in the tropical and subtropical boundaries of the Indo-Pacific region (Marsh *et al*., 1978; Nishiwaki & Marsh,1985). The dugong is the only existing species in the order Sirenia that includes two different families, the Dugongidae (dugong) and Trichechidae (manatees) (Domning 2001). The dugong's ranges through the waters of about 48 countries between about 26º N and 27º S of the equator from East Africa to the Solomon Islands and Vanuatu (Marsh 2008).

Dugongs are influenced by threatening processes which include habitat destruction or modification, pollution, direct human exploitation, mortality or boats injury from interactions with fisheries, habitat loss and degradation of seagrass ecosystems (Marsh *et al*. 1999, 2002; Preen 1995). Fisheries have a direct effect on dugongs as they are being caught as by-catch, especially by gill nets (Marsh 2002). Vessel strikes and ecotourism might put the dugongs at high risk (Marsh *et al*. 2002; Hodgeson & Marsh 2007). Dugong-watching tour boats can frighten them away from critical resources and consequently degrade their habitat (Gerrard 1999).

All surviving members of order Sirenia (including the dugong) are listed as vulnerable to extinction (Hilton-Taylor 2000; IUCN 2007, 2011). Dugongs are listed in Appendix 1 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The dugong is vulnerable to extinction because it has a low reproductive output as it feeds only on seagrass which occurs in constrained habitats in coastal waters (Marsh *et al*. 2002). The dugong is considered useful by conservation biologists, conservationists and government managers for assigning the broader issues of conservation to the community (Entwistle & Dunstone 2000).

In Egypt, the Dugong is protected under the *Wildlife Conservation Act* 1950, but its conservation status is still indeterminate (Hanafy *et al*. 2006). The Egyptian Environmental Affairs Agency (EEAA) commenced a study in 2001 with the objective of identifying the spatial distribution of Dugongs in Egypt's the Red Sea particularly around marine protected areas (MPA). In addition to quantifying the relative abundance of dugongs through time; identifying the primary habitat for this species and the vigorous sources of Dugong mortality to target management action is essential.

Large herbivores or mega-grazers such as dugongs play a significant role in the seagrass communities' structure, however, understanding their relative importance has been hindered by the lack of studies (Ebrahim *et al*. 2014 & Bessey *et al.* 2016). D'Souza *et al.* (2015) studied the way by which dugongs use their habitat and move between foraging grounds; they showed that this understanding has significant consequences for the management of these mega-grazers' populations in Andaman Island and Nicobar archipelago, India. Those authors were able to determine the characteristics of seagrass meadows that dugongs use continuously; they tracked the persistence of use (presence of feeding trails).

Unlike most other herbivores that feed exclusively on leaves, dugongs usually feed on the entire plant, including shoots, rhizomes and roots (Preen 1995). This is mainly a destructive form of feeding, resulting in seagrass meadows dominated by pioneering species kept at low overall biomass by repeated grazing. During feeding, dugongs excavate along winding feeding tracks in seagrass beds that are known as feeding trails (Preen 1995 & Anand 2012). Those trails are the best evidence of dugong feeding and are common in many tropical intertidal regions, including the Great Barrier Reef and sub-tropical locations such as Morton Bay and Hervey Bay in south-east Queensland and Shark Bay on the western coast of Australia (De Iongh *et al*. 2007).

Red Sea dugongs are scattered distributed and mainly sighted solitary, in pairs and sometimes in a group of three individuals. Dugong encountering underwater is rare and once occurs for a short time. In the previous projects by Rufford Foundation (i.e., RSG 17553-1 and 21354-2) 30 dugongs were identified using photo identification technique in Marsa Alam and Wadi El Gemal National Park (Shawky et al. 2017; 2019). Dugong feeding trails are mainly recorded on the seagrass beds that differed in intensity from one site to another. In the Egyptian Red Sea, the variation in the width of feeding trails measurements indicated that different individuals visited each site was studied (Shawky, 2018a).

The aims of work were:

1. Estimate the temporal and spatial variation of seagrass abundance.
2. Identify the temporal and spatial variation of the feeding trails.
3. Examine a relationship between the dugong muzzle width and total body length using laser photogrammetry technique.
4. Create predictive modelling maps for suitable dugong habitats and calving.
5. Raise awareness of dive guides, snorkelling guides and local communities.
6. Preparing the first management plan for dugong conservation in Egypt.

2. Methods

2.1 **Study sites:**

The data were collected seasonally from seven different sites located in three regions at different timings; Qosseir, Marsa Alam and Wadi El Gemal National Park (WGNP). One site was selected in Qosseir: Sheikh Malek (25°43'25.80"N and 34°33'10.09"E), three sites were selected in Marsa Alam: Marsa Mobarak (25°30'41.38"N and 34°39'0.67"E), Marsa Abou Dabbab (25°20'16.96"N and 34°44'20.48"E) and Marsa Hermez (25°19'12.65"N and 34°44'45.34"E). The other three sites in WGNP were Shams Alam (24°41'28.08"N and 35° 5'7.48"E), Ras Baghdady (24°39'43.67"N and 35° 6'39.71"E) and Wadi El Gemal Island (24°39'43.40"N and 35° 9'29.13"E) (Figure 1). These sites were chosen due to the presence of seagrass beds and feeding trails. More details of the study sites are shown in the Satellite images (Appendix 1).

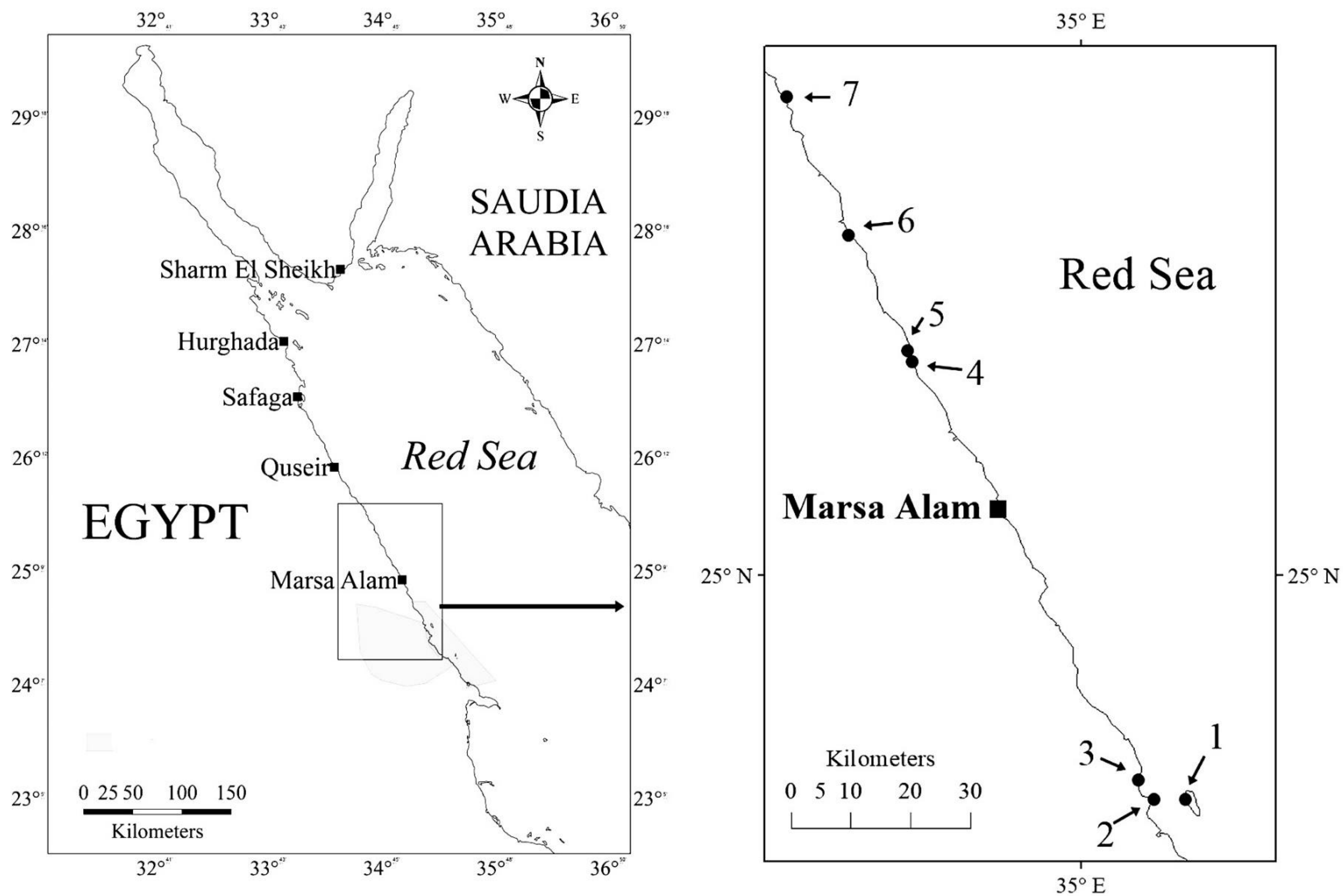


Figure 1: Map of the Egyptian Red Sea (left) and the details of the study sites: 1, Wadi El-Gemal Island; 2, Ras Baghdady; 3, Shams Alam; 4, Marsa Hermez; 5, Marsa Abou Dabbab; 6, Marsa Mobarak; 7, Sheikh Malek.

2.2 **Methodology:**

2.2.1 Seagrass abundance:

Four 20m line transects were constructed in the seagrass area. Seagrass abundance was assessed in 10 randomly located quadrats (0.25m^2) at 2m intervals along each transect (40 quadrats/ site) (Figure 2). They were displaced if they fell over an area where a feeding trail occurred (Preen 1992). The relative abundance of seagrass in each quadrat was estimated by counting the shoots of each species. The data was collected underwater by means of SCUBA diving. Each quadrat was photographed using an HD digital camera (GoPro Hero 4 Silver Edition). Photos were later displayed on a laptop screen, zoomed and seagrass shoots were counted. Identification of seagrasses was carried out after on El Shaffai (2016).

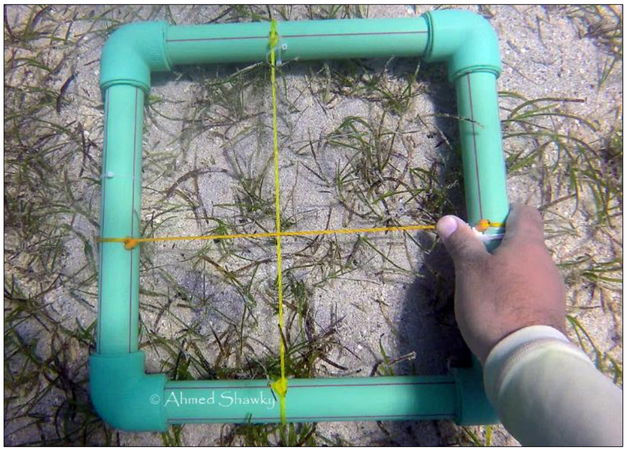


Figure 2: 0.25m^2 quadrat used for the estimation of seagrass abundance.

2.2.2 Feeding trails:

According to Preen (1992) and (Amamoto *et al.* 2009), feeding trails were measured for their width (cm) and length (m) by means of a ruler and a plastic tape measure respectively (Figure 3).

Figure 3: Measurement of feeding trail length (left) and width (right).

2.2.3 Laser photogrammetry:

A laser photogrammetry system with two beams of green laser light (Moray Inc.; < 5 mW power) with calibrated 20 cm distance was mounted on a housed GoPro camera and the lens is set in wide view (Figure 4). To calculate the correction factor, a grid of 10 x 10 squares (5 cm each) was photographed and the pixels across the diagonal of the middle square was measured then multiplied by 2, 3, 4, 5, 6, 7, 8, 9 and 10 respectively (Figure 5). The observed vs. expected values were plotted in Microsoft Excel program and a linear regression was fitted to calculate any changes with lens curvature and the setting of the camera (Rohner *et al.* 2015). Photos from two meters away were taken perpendicular on the body (Figure 6 and 7) to measure the total body length and muzzle width (Figure 8 and 9) of the dugong after Heinsohn (1981). All photos were analyzed to measure the distance using Image J Software. Using this technique, a relationship between the dugong total body length, muzzle width and feeding trail width will be calculated, then the estimation of the population size could be determined from the presence of feeding trails on the seagrass bed. More photos for using the laser photogrammetry with the dugong is in Appendix 2.

Figure 4: The laser unites with 20cm apart and Go Pro camera.

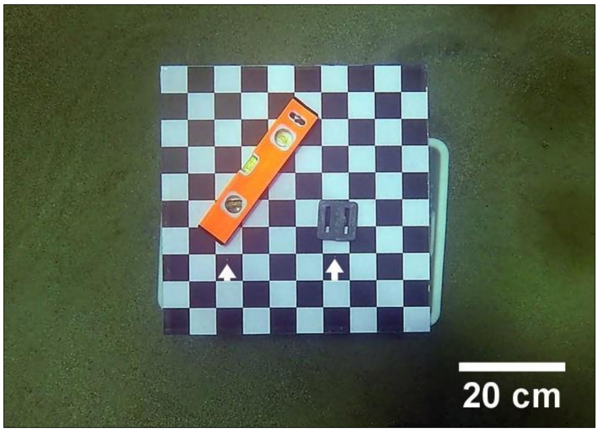
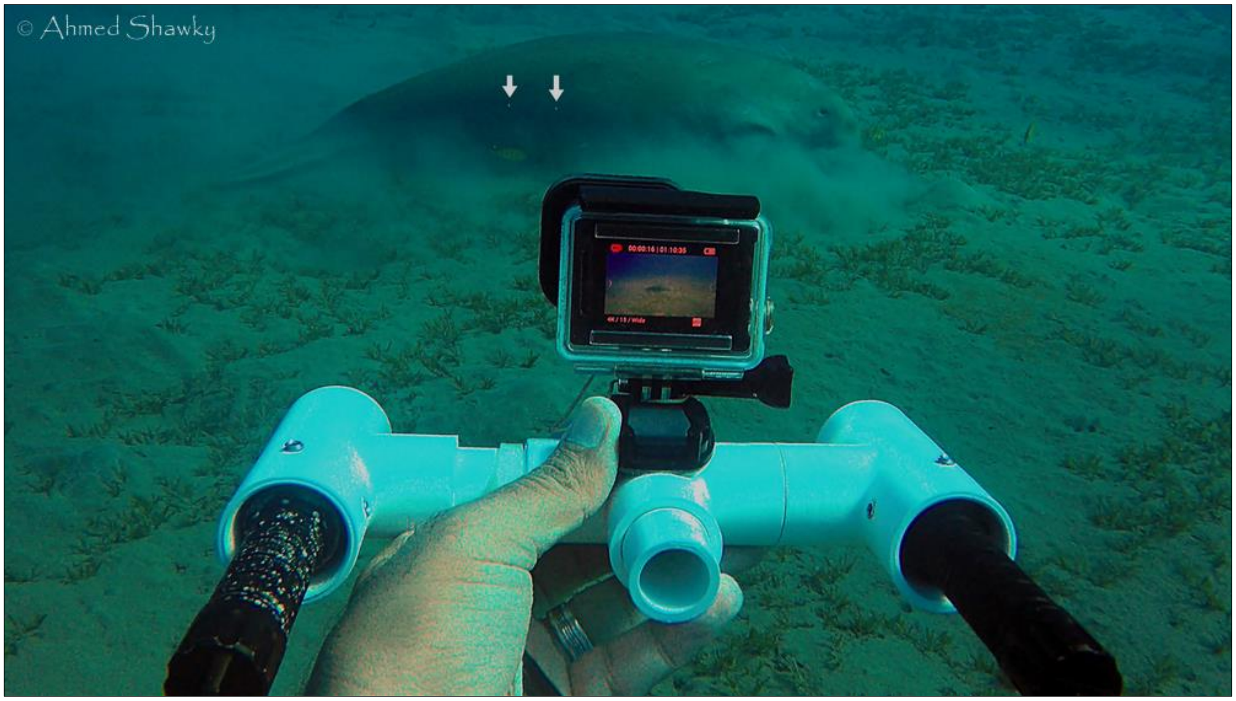


Figure 5: Gride of 50cm and two laser dots pointed by the white arrow for calibration.

Figure 6: The researcher Ahmed M. Shawky using laser unit during diving with the dugong.



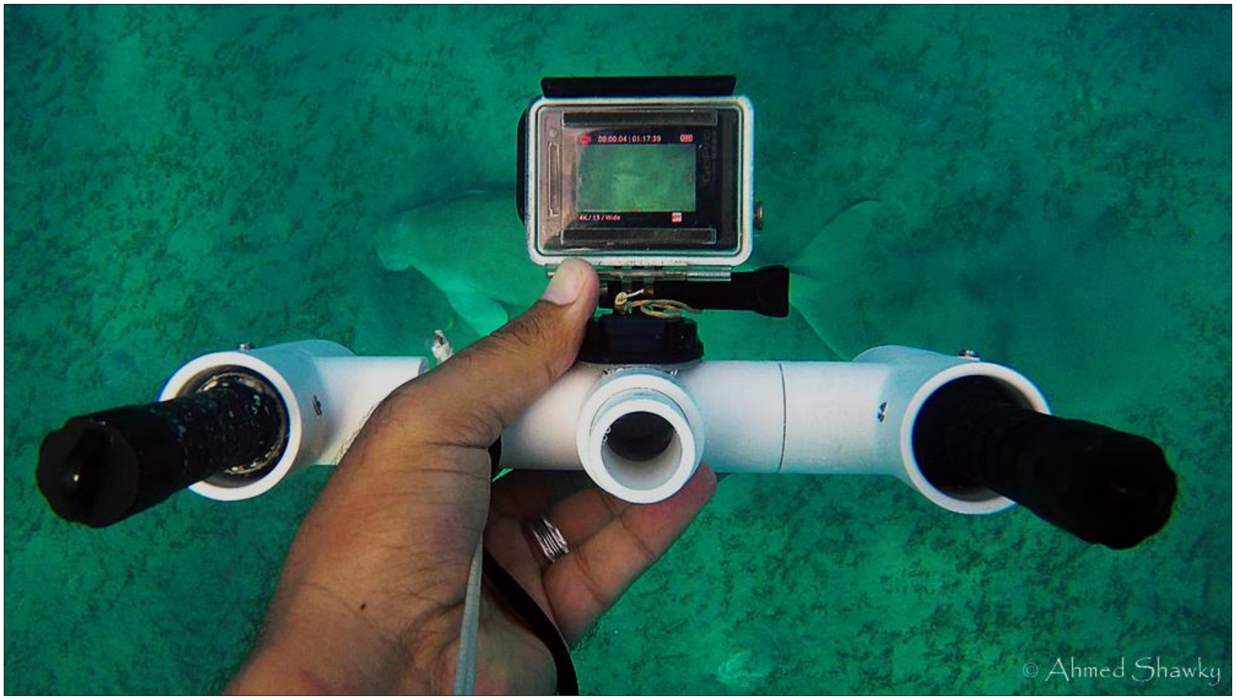


Figure 7: Focusing the laser unite perpendicular to the dugong from the side (upper photo) and from the top (below photo).

Figure 8: Ahmed M. Shawky is focusing the laser on the dugong muzzle by snorkelling.

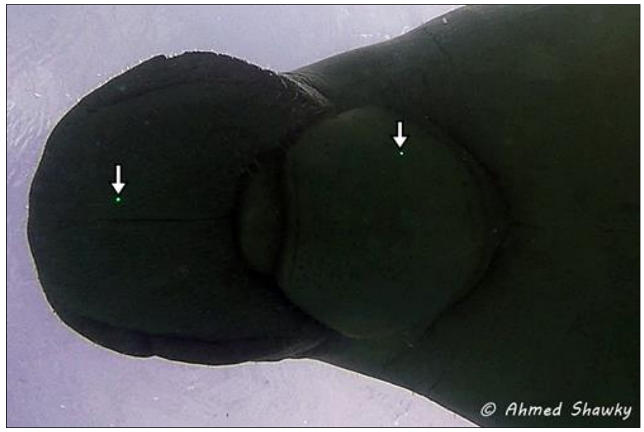


Figure 9: Two green laser dots on the dugong muzzle pointed by arrows.

2.2.4 Modelling:

Maxent modelling of the dugong calving and suitable habitat were completed using MaxEnt software version 3.3.3k. Bathymetry data was got from General Bathymetric Chart of the Oceans GEBCO, http://www.gebco.net/ noticed at April 2016. The list of environmental variables used involved bathymetry, proximity to the shoreline, proximity to fishing grounds, proximity to seagrass bed, salinity, solar radiation, Slope of Seafloor as percentage, sea surface means temperature, sea surface maximum temperature and sea surface minimum temperature. Area Under Curve AUC was used as a diagnostic to estimate the model fit as the TSS statistic (Allouche, Tsoar, Kadmon, 2006).

2.2.5 Public awareness:

The outline of PADI Dugong Conservation distinctive speciality diver course is used in all presentations and training to the dive and snorkelling guides (Shawky 2018b).

3. Results

3.1 Seagrass abundance:

Five different seagrass species were recorded in the all study sites namely; *Halophila stipulacea*, *Halophila ovalis*, *Halodule uninervis*, *Cymodocea rotundata* and *Syringodium isoetifolium* that varied in time and space (Figure 10).

3.1.1 According to seasons:

Halophila stipulacea was the most dominant species in winter (71±2%) and decreased in summer (56.3±3%) (Figure 11). *Halophila ovalis* was the most dominant species in autumn (27.3±2%) and decreased in winter (15±1%). *Halodule uninervis* was the most dominant species in summer (23.1±2%) and decreased in autumn (11.4±1%). *Cymodocea rotundata* was the most dominant species in summer (2.8±1%) and decreased in spring (0.6±0%). *Syringodium* *isoetifolium* was the most dominant species in summer (0.9±0%) and decreased in autumn (0.1±0%).

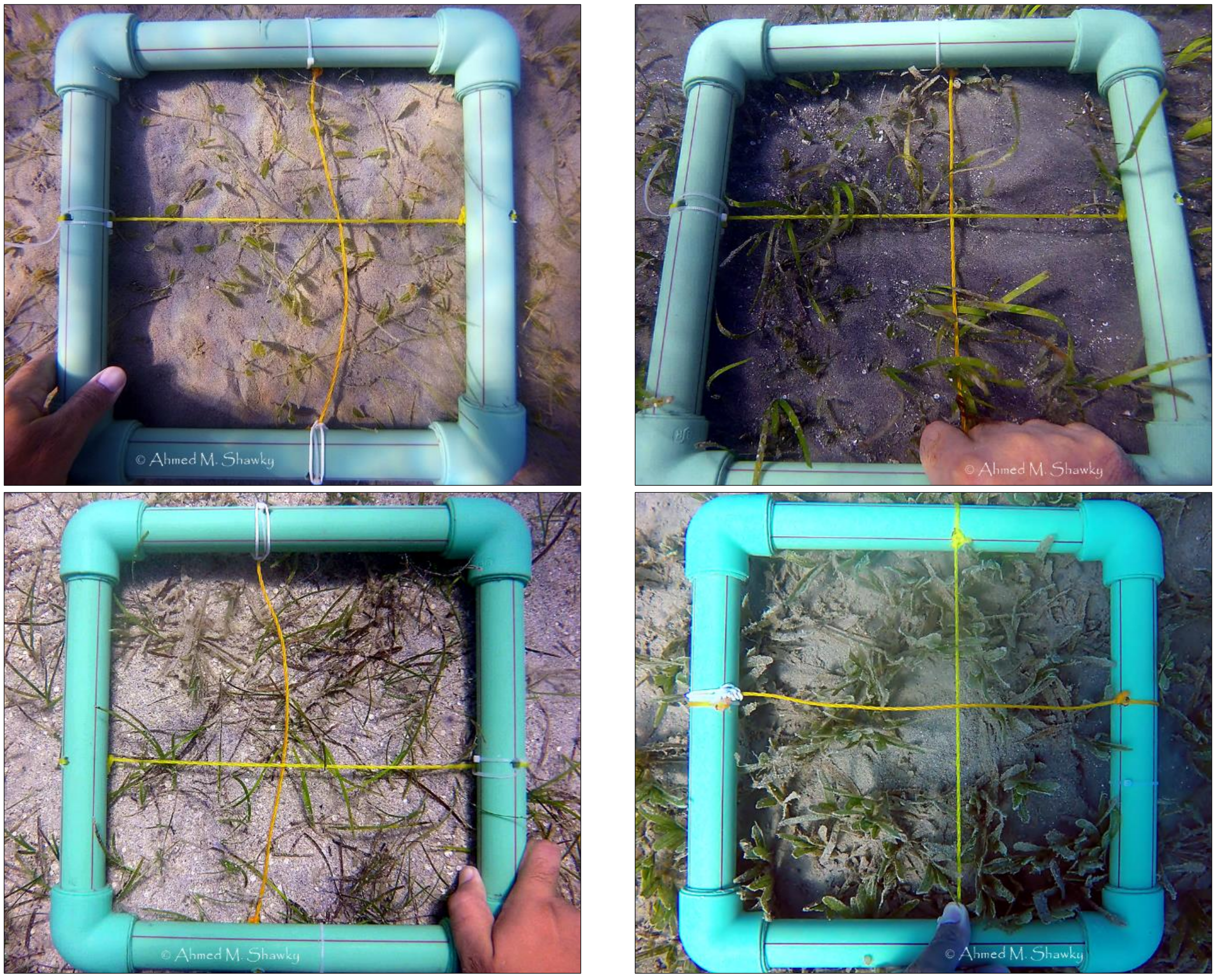


Figure 10: Examples of different species of seagrass in the study sites.

3.1.2 According to sites:

In Wadi El-Gemal Island, *Halophila stipulacea* was the most dominant species (64.2±2.3%), then *Halophila ovalis* (21.6±1.8%) (Figure 12). In Ras Baghdady, *Halophila ovalis* was the most dominant species (46.9±2.7%), then *Halodule uninervis* (43±2.7%). In Shams Alam, *Halophila stipulacea* was the most dominant species (66.4±2.7%), then *Halodule ovalis* (17.3±2%). In Marsa Hermez, *Halophila stipulacea* was the most dominant species (90.6±1.8%), then *Halophila ovalis* (9.3±1.8%). In Marsa Abou Dabbab, *Halophila stipulacea* was the most dominant species (73.6±3%), then *Halodule ovalis* (25.2±3%). In Marsa Mobarak, *Halodule uninervis* was the most dominant species (45.2±3.2%), then *Halophila stipulacea* (34.9±3.3%). In Sheikh Malek, *Halodule uninervis* was the most dominant species (98±0.5%), then *Halophila ovalis* (1.6±0.5%). Summary of the abundance for the different seagrass species per seasons and sites are shown in tables (1, 2, 3 and 4).

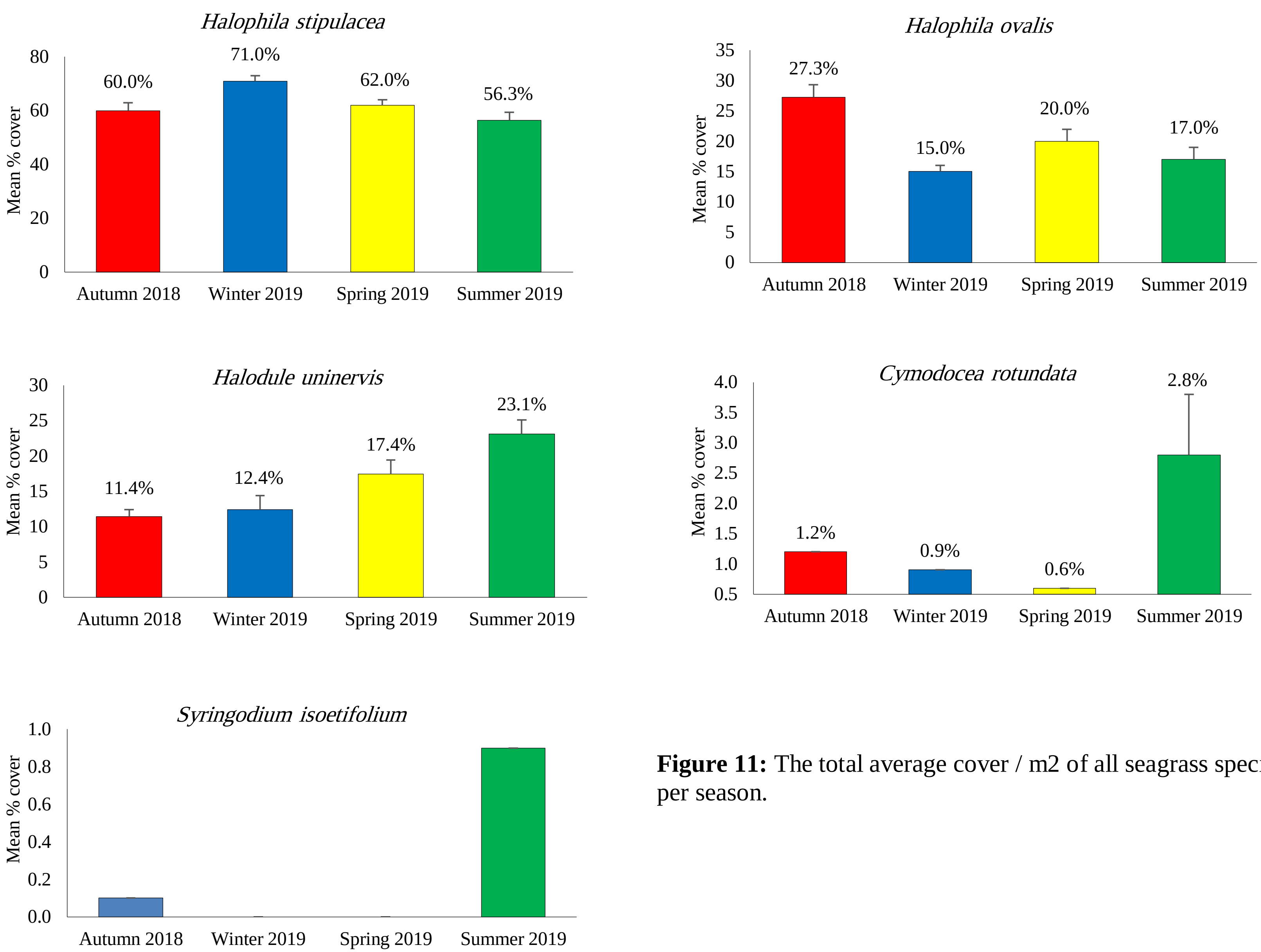


Figure 11: The total average cover / m2 of all seagrass species per season.

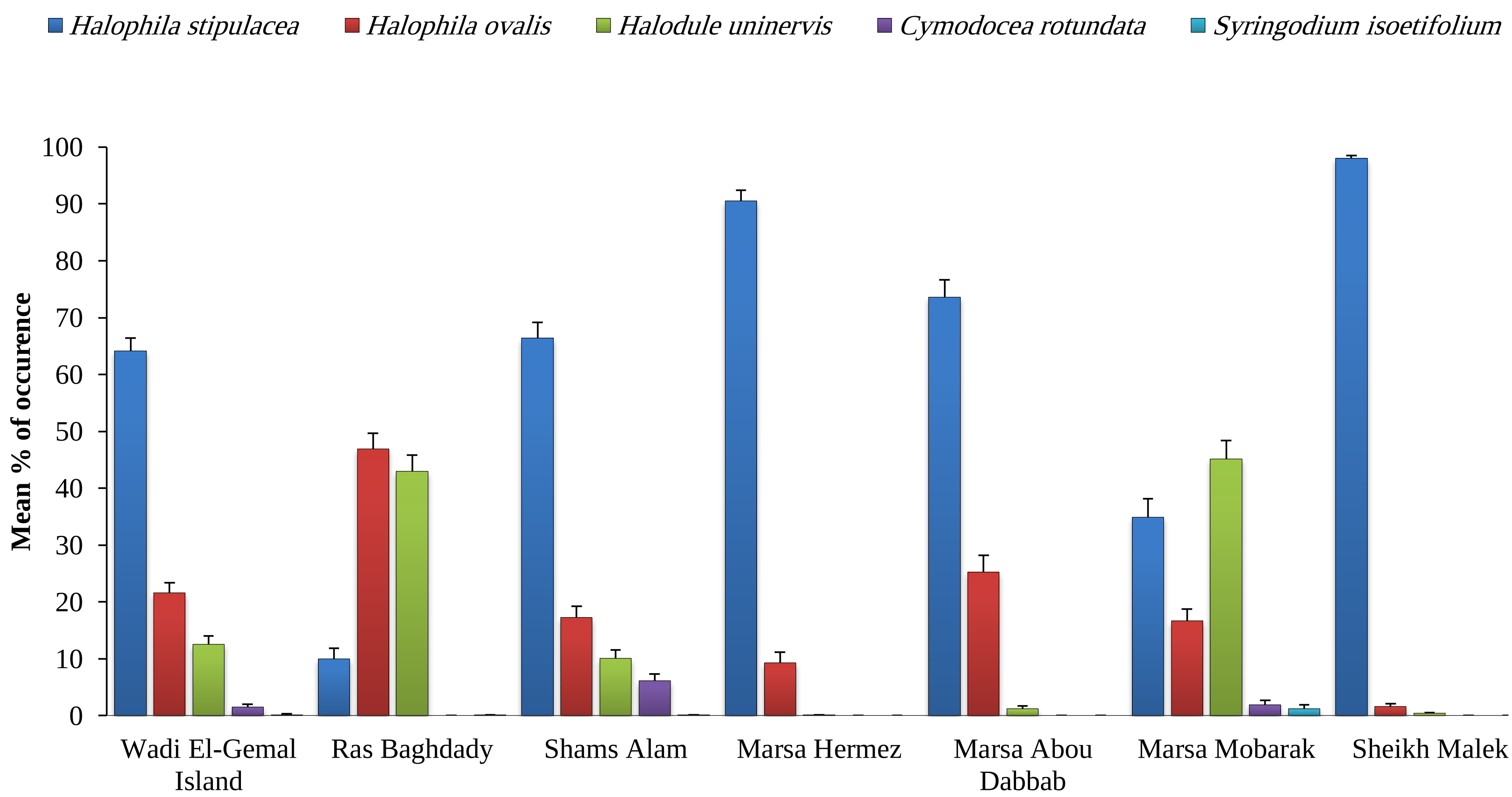


Figure 12: The total average cover / m2 of all seagrass species at the study sites.

Table 1:
Data summary of the abundance of different seagrass species in **Autumn 2018** of the study sites; site 1, Wadi El Gemal Island; site 2, Ras Baghdady; site 3, Shams Alam; site 4, Marsa Hermez; site 5, Marsa Abou Dabbab; site 6, Marsa Mobarak and site 7, Sheikh Malek.

Site No.	Seagrass species														
	Halophila stipulacea			*Halophila ovalis*			*Halodule uninervis*			*Cymodocea rotundata*			*Syringodium isoetifolium*		
	Range	Mean±SE	n	Range	Mean±SE	n	Range	Mean±SE	n	Range	Mean±SE	n	Range	Mean±SE	n
1	48-2752	1015±115	39	16-2240	506±92	34	16-576	212±45	19	-	-	-	-	-	-
2	16-960	211±40	24	64-4096	1325±152	40	128-3008	862±110	39	-	-	-	16-192	88±37	4
3	16-2064	567±84	38	32-1376	502±61	40	16-1648	222±58	36	32-512	199±65	7	16-64	40±24	2
4	736-1936	1235±47	40	-	-	-	-	-	-	-	-	-	-	-	-
5	16-768	237±35	31	16-592	237±34	25	16-32	24±5	4	-	-	-	-	-	-
6	64-2320	1217±126	28	64-1952	683±153	16	96-2016	679±140	18	16-720	267±91	9	-	-	-
7	192-1936	756	59	-	-	-	-	-	-	-	-	-	-	-	-

Table 2:
Data summary of the abundance of different seagrass species in **Winter 2019** of the study sites; site 1, Wadi El Gemal Island; site 2, Ras Baghdady; site 3, Shams Alam; site 4, Marsa Hermez; site 5, Marsa Abou Dabbab; site 6, Marsa Mobarak and site 7, Sheikh Malek.

Site No.	Seagrass species														
	Halophila stipulacea			*Halophila ovalis*			*Halodule uninervis*			*Cymodocea rotundata*			*Syringodium isoetifolium*		
	Range	Mean±SE	n	Range	Mean±SE	n	Range	Mean±SE	n	Range	Mean±SE	n	Range	Mean±SE	n
1	560-2320	1142±73	40	16-1360	303±51	39	16-1280	166±46	32	16-512	201±66	7	-	-	-
2	16-1920	286±94	23	16-1008	281±39	34	16-2240	674±107	32	-	-	-	32	32	1
3	240-976	520±29	40	16-144	64±10	22	16-272	74±17	16	16-80	48±9	6	-	-	-
4	32-512	206±21	39	16-352	84±21	19	-	-	-	-	-	-	-	-	-
5	96-2240	1520±88	40	32-400	132±43	8	-	-	-	-	-	-	-	-	-
6	32-832	242±37	33	32-1040	242±49	30	16-1520	360±78	28	16-320	106±56	5	-	-	-
7	80-1424	217±33	40	-	-	-	-	-	-	-	-	-	-	-	-

Table 3:

Data summary of the abundance of different seagrass species in **Spring 2019** of the study sites; site 1, Wadi El Gemal Island; site 2, Ras Baghdady; site 3, Shams Alam; site 4, Marsa Hermez; site 5, Marsa Abou Dabbab; site 6, Marsa Mobarak and site 7, Sheikh Malek.

Site No.	Seagrass species														
	Halophila stipulacea			*Halophila ovalis*			*Halodule uninervis*			*Cymodocea rotundata*			*Syringodium isoetifolium*		
	Range	Mean±SE	n	Range	Mean±SE	n	Range	Mean±SE	n	Range	Mean±SE	n	Range	Mean±SE	n
1	800-24800	1135±94	38	32-2352	734±100	40	32-1280	303±51	36	48-480	222±56	8	-	-	-
2	16-288	128±33	12	16-920	585±106	33	112-2160	1021±159	19	-	-	-	-	-	-
3	80-1344	652±54	39	32-1632	269±107	15	16-480	115±46	12	16-80	41±6	15	-	-	-
4	80-1488	476±73	29	16-1360	487±92	21	16-240	68±25	8	-	-	-	-	-	-
5	144-2160	1068±97	40	32-800	197±52	17	6-48	32±9	3	-	-	-	-	-	-
6	32-1600	625±119	22	16-96	50±8	13	96-2160	1158±106	33	-	-	-	-	-	-
7	96-1360	702±54	40	16-1192	54±11	16	16-80	50±9	7	-	-	-	-	-	-

Table 4:
Data summary of the abundance of different seagrass species in **Summer 2019** of the study sites; site 1, Wadi El Gemal Island; site 2, Ras Baghdady; site 3, Shams Alam; site 4, Marsa Hermez; site 5, Marsa Abou Dabbab; site 6, Marsa Mobarak and site 7, Sheikh Malek.

Site No.	Seagrass species														
	Halophila stipulacea			*Halophila ovalis*			*Halodule uninervis*			*Cymodocea rotundata*			*Syringodium isoetifolium*		
	Range	Mean±SE	n	Range	Mean±SE	n	Range	Mean±SE	n	Range	Mean±SE	n	Range	Mean±SE	n
1	16-560	145±21	38	16-560	75±41	13	16-560	105±19	26	32-80	52±10	4	16-48	32±9	3
2	48	48	1	48-1840	644±65	36	32-2448	835±116	37	-	-	-	16-32	21±5	3
3	48-1360	343±49	35	16-592	152±36	21	16-1024	222±50	20	32-880	249±51	20	16-32	24±8	2
4	96-976	380±35	35	48-592	273±40	18	-	-	-	-	-	-	-	-	-
5	96-992	372±31	40	16-352	153±44	7	16-32	21±5	-	-	-	-	-	-	-
6	16-656	161±59	11	16-960	242±48	25	16-2096	560±88	36	-	-	-	16-544	192±78	7
7	48-752	278±24	40	16-80	44±14	4	-	-	-	-	-	-	-	-	-

3.2 Feeding trails:

3.2.1 According to the season:

Regarding trail width, in winter, 12 of different sizes of trail width were recorded followed by 11 in spring, were decreased to only eight different sizes in autumn and summer (Figure 13). The trail width of 20cm was the most dominant size in all seasons. The largest width of 30cm wide was recorded in winter (3%) and spring (1%) only. No small feeding trail was recorded in summer.

3.2.2 According to sites:

Marsa Abou Dabbab is the most site that recorded 10 different sizes of trail width, followed by Ras Baghdady, While Marsa Mobarak is the lowest site of trail widths with only four different sizes followed by Sheikh Malek with five sizes (Figure 14). All study sites were recorded for the presence of small feeding trail widths that related to the presence of calves. On the other hand, the largest trail width of 30cm was recorded only in Marsa Hermez (3.8%) and Sheikh Malek (1.3%). The result of 30cm wide was documented and published in a scientific journal entitled "**Egyptian Journal of Aquatic Research**" (Shawky 2019). Examples of different feeding trails with different sized in width are shown (Figure 15).

Regarding trail length, it was varied between less than 1m until close to 8m in the study sites seasonally (Figure 16). In summer, no feeding trials were recorded in Wadi El-Gemal Island The data was classified into eight categories: <1m, 1-2m, 2-3m, 3-4m, 5-6m, 6-7m and 7-8m. The class size of 2-3m most the dominant length in winter (39.4%), autumn (35.5%) and spring (28.9%), while in summer the class size of 1-2m was dominant. The trail lengths less than 1m were dominant in winter (17.8%) and disappeared in autumn.

3.2.3 Mother dugong with calf:

The high percentage for the presence of mother with calf was recorded in winter (44%) then in autumn (38%) and completely absent in summer (Figure 17). According to sites, the mother with calf was recorded in all the study sites. Wadi El-Gemal Island is the most dominant site that was recorded the mother dugong with the calf (39.5%) followed by Marsa Hermez (18.4%), while Sheikh Malek is the lowest (2.6%) (Figure 18).

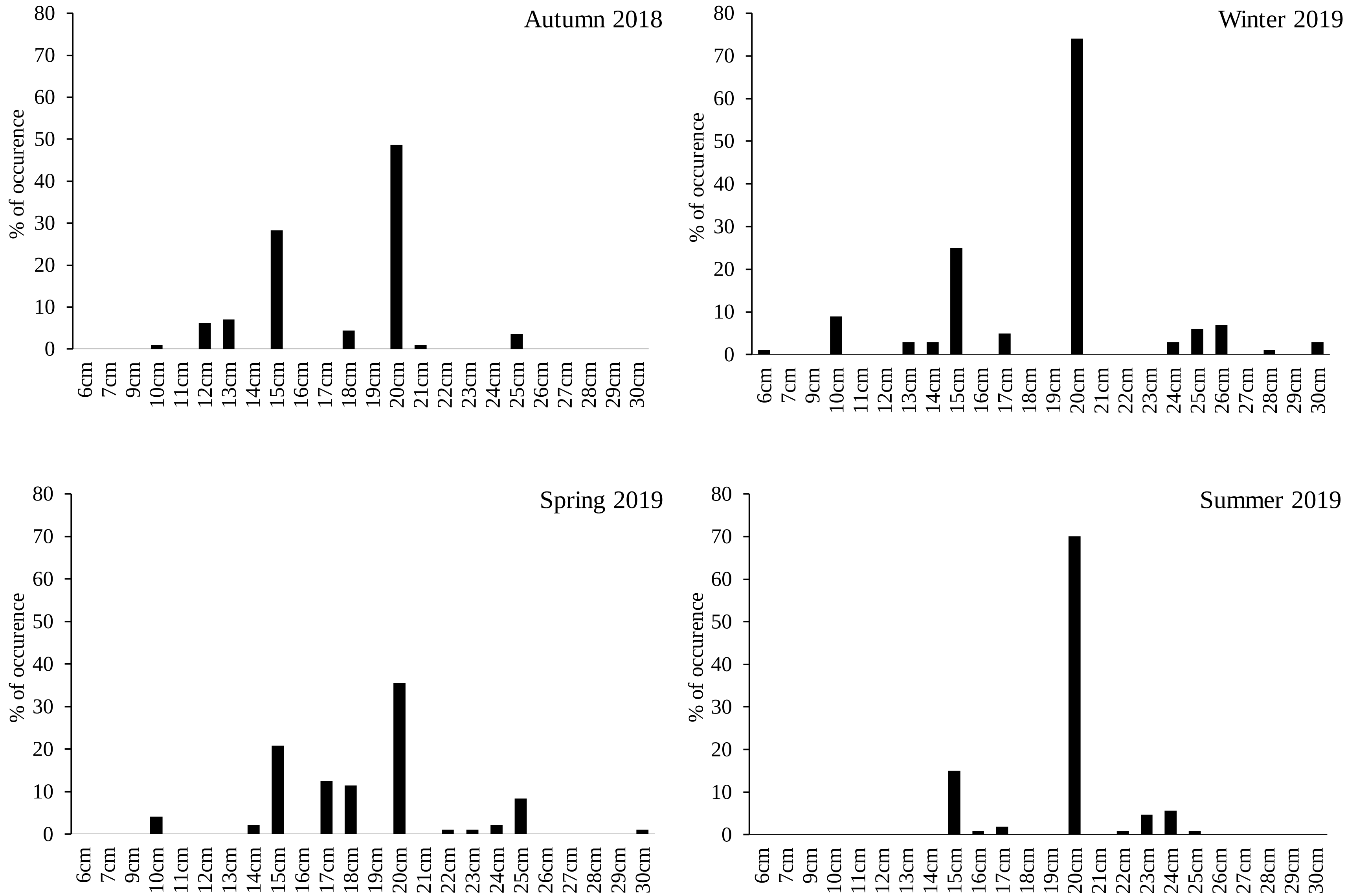


Figure 13: Seasonal variation in size categories of the feeding trail widths in all the study sites.

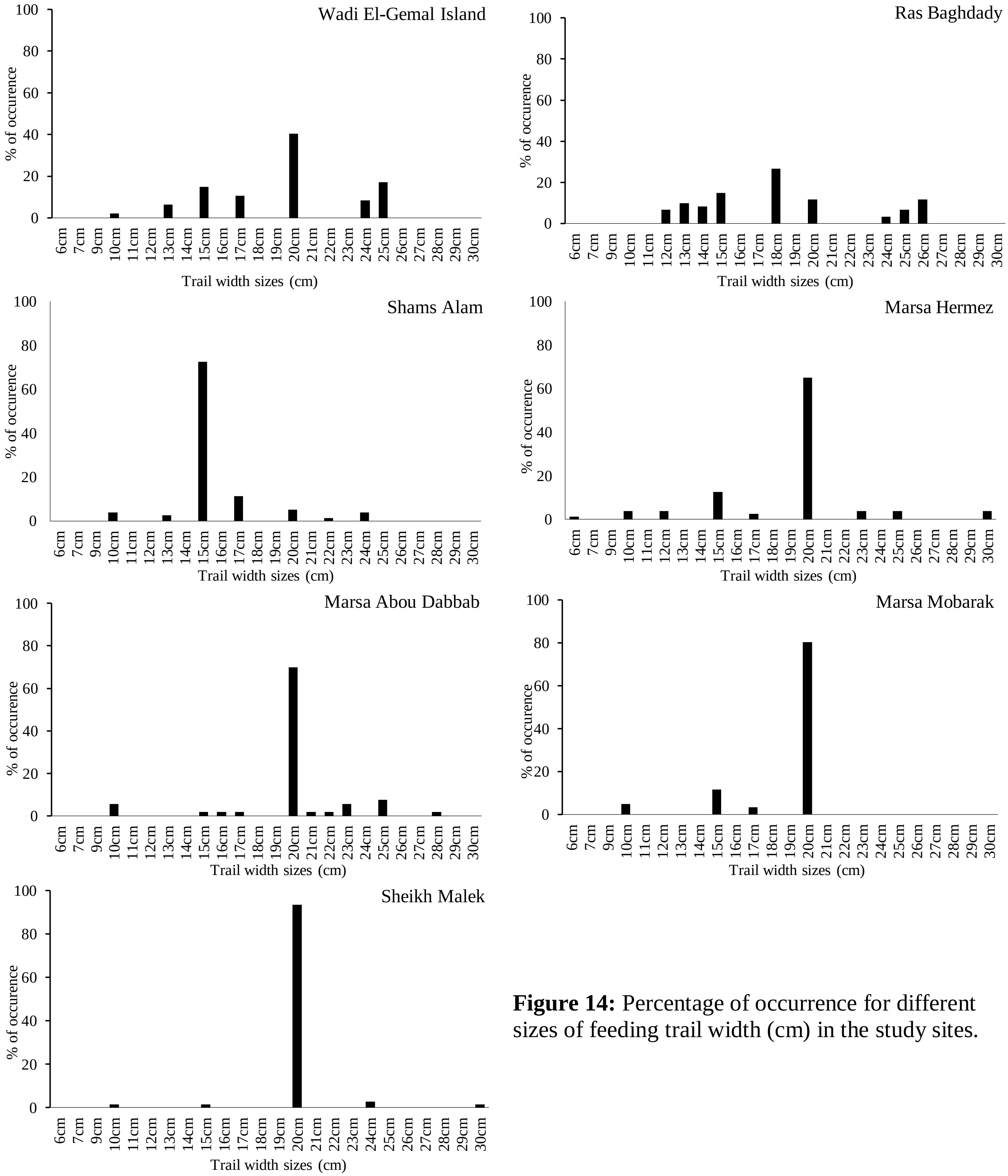


Figure 14: Percentage of occurrence for different sizes of feeding trail width (cm) in the study sites.

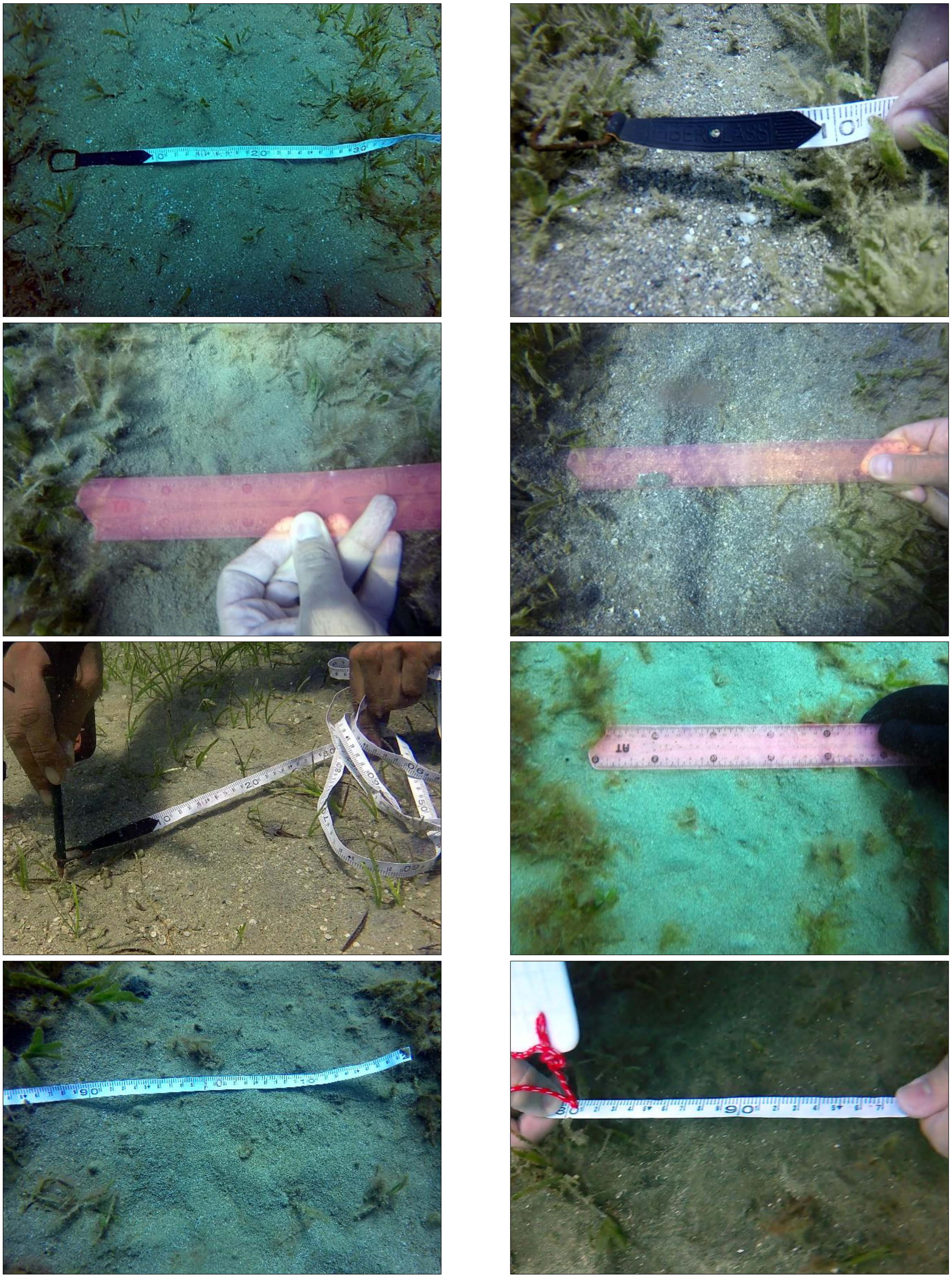


Figure 15: Examples of different sizes of trail width recorded during the study.

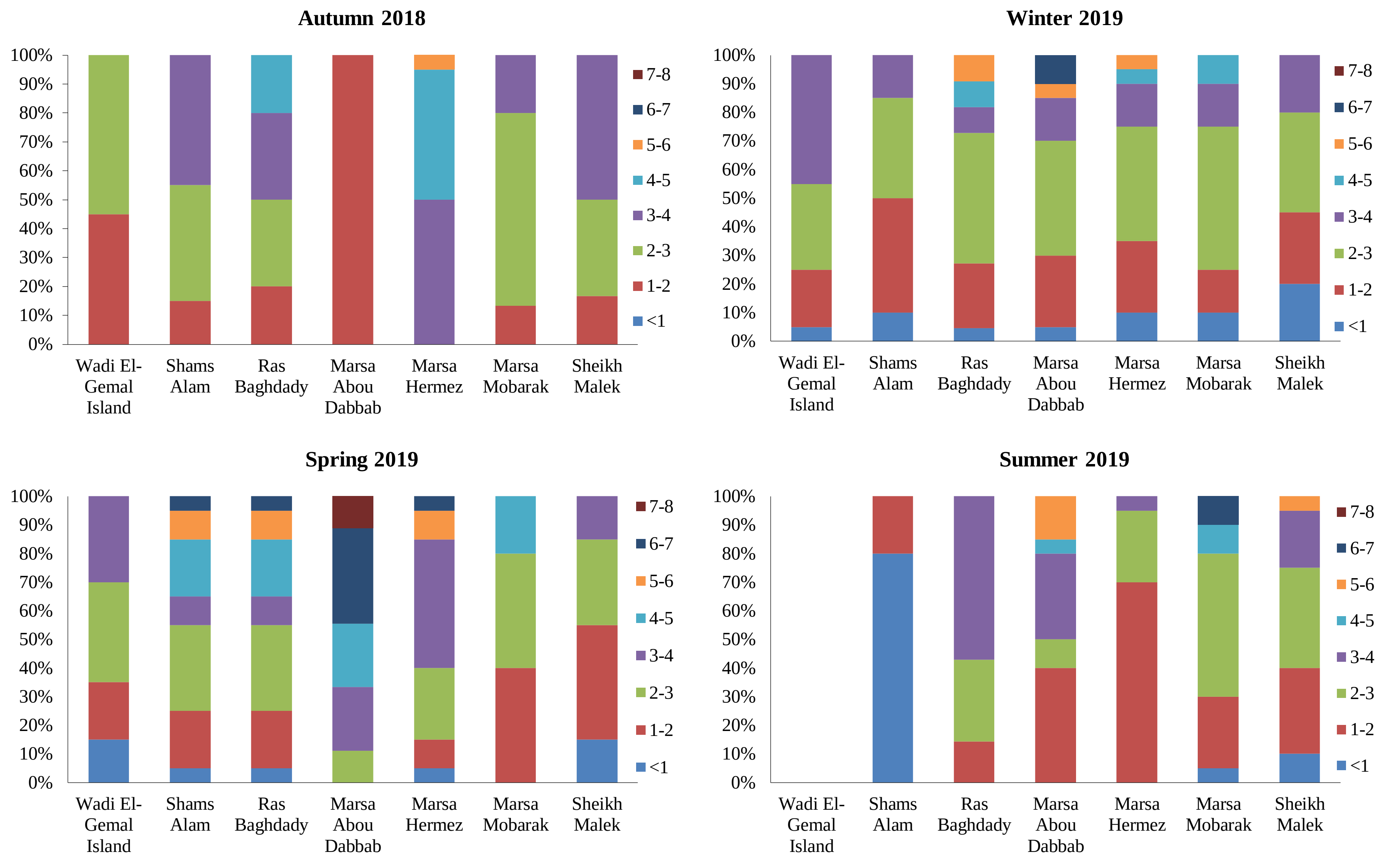


Figure 16: Percentage of different class sizes of trail length in different seasons in the study sites.

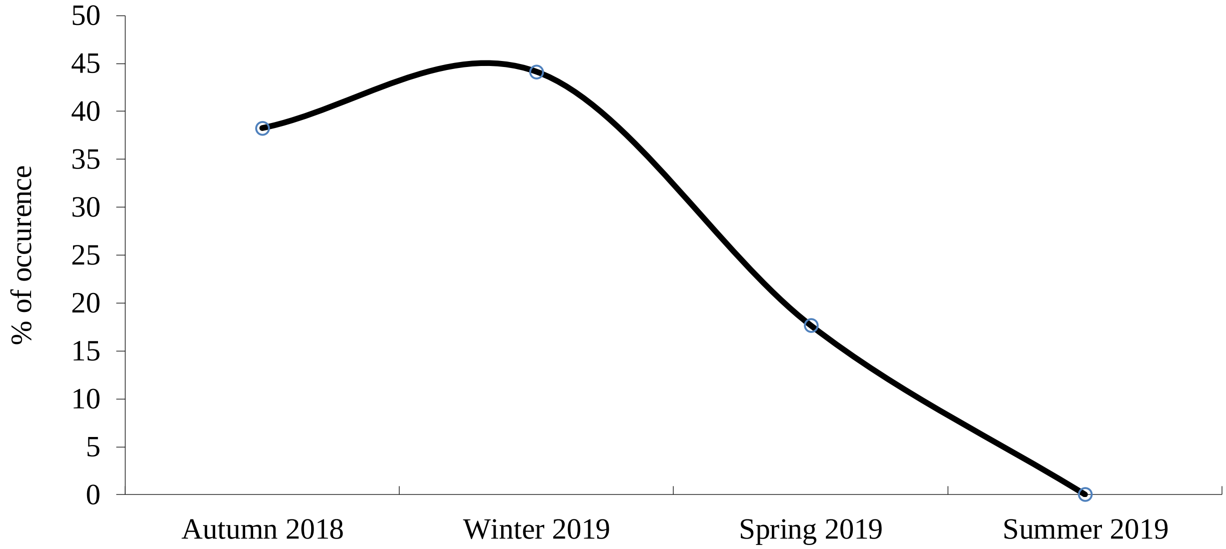


Figure 17: Seasonal variation of the percentage of existence for the mother dugong with calf.

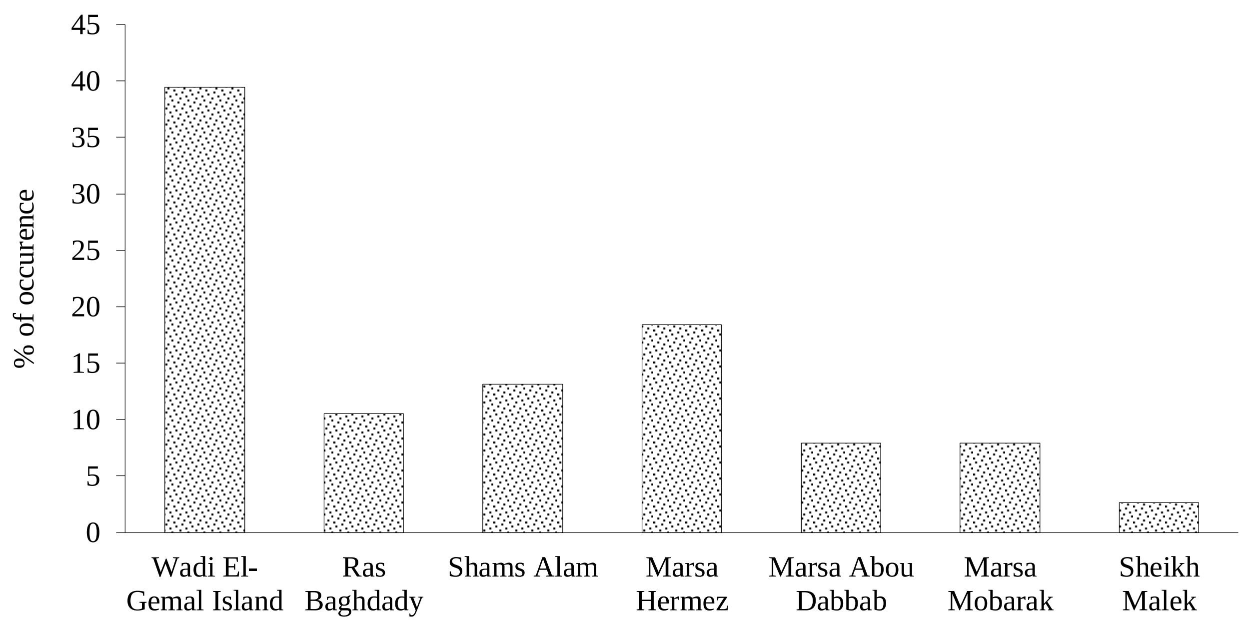


Figure 18: The percentage of existence for the mother dugong with the calf in the study sites.

3.3 Laser photogrammetry:

To get the correction factor using GoPro Camera, three different equation was got for the three mode view of the camera for narrow, medium and wide-angle of the camera lens. With practice in the field, the wide view mode was the best one to apply (Figure 19).

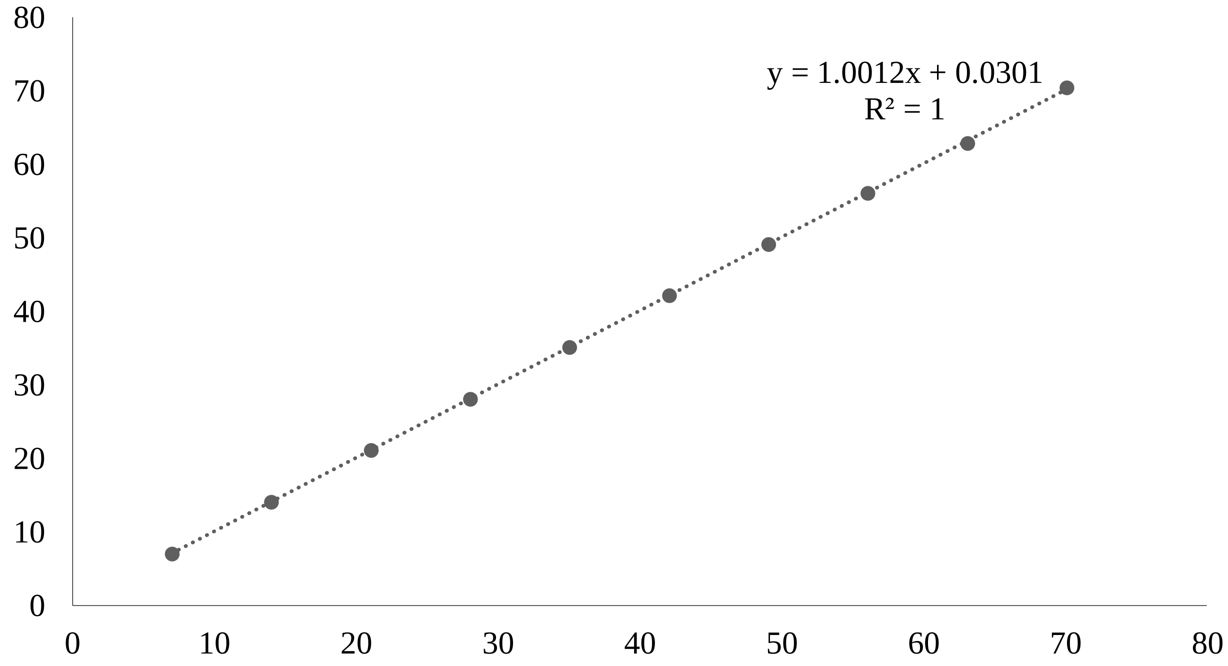


Figure 19: The equation of the correction factor for the wide-angle mode of GoPro Camera.

Three different adult dugongs were measured using laser photogrammetry techniques. Total length and muzzle width were measured successfully in addition to the trail width that created by these dugongs. First dugong #MMO26 that most dominant in Marsa Mobarak was measured of 277.7 cm length (Figure 20). Second dugong #MHE19 that most dominant in Marsa Hermez and Marsa Abou Dabbab were measured with a total length of 280 cm length (Figure 21). Third dugong #SMA31 that most dominant to Sheikh Malek was measured with 265.5 cm length (Figure 22).

Measurements for other individuals not occurred successfully due to their far distance and swam quickly. So, the results of the estimation of the dugong body length from the feeding trails will not be published in this report until more different dugongs will be measured in further study.

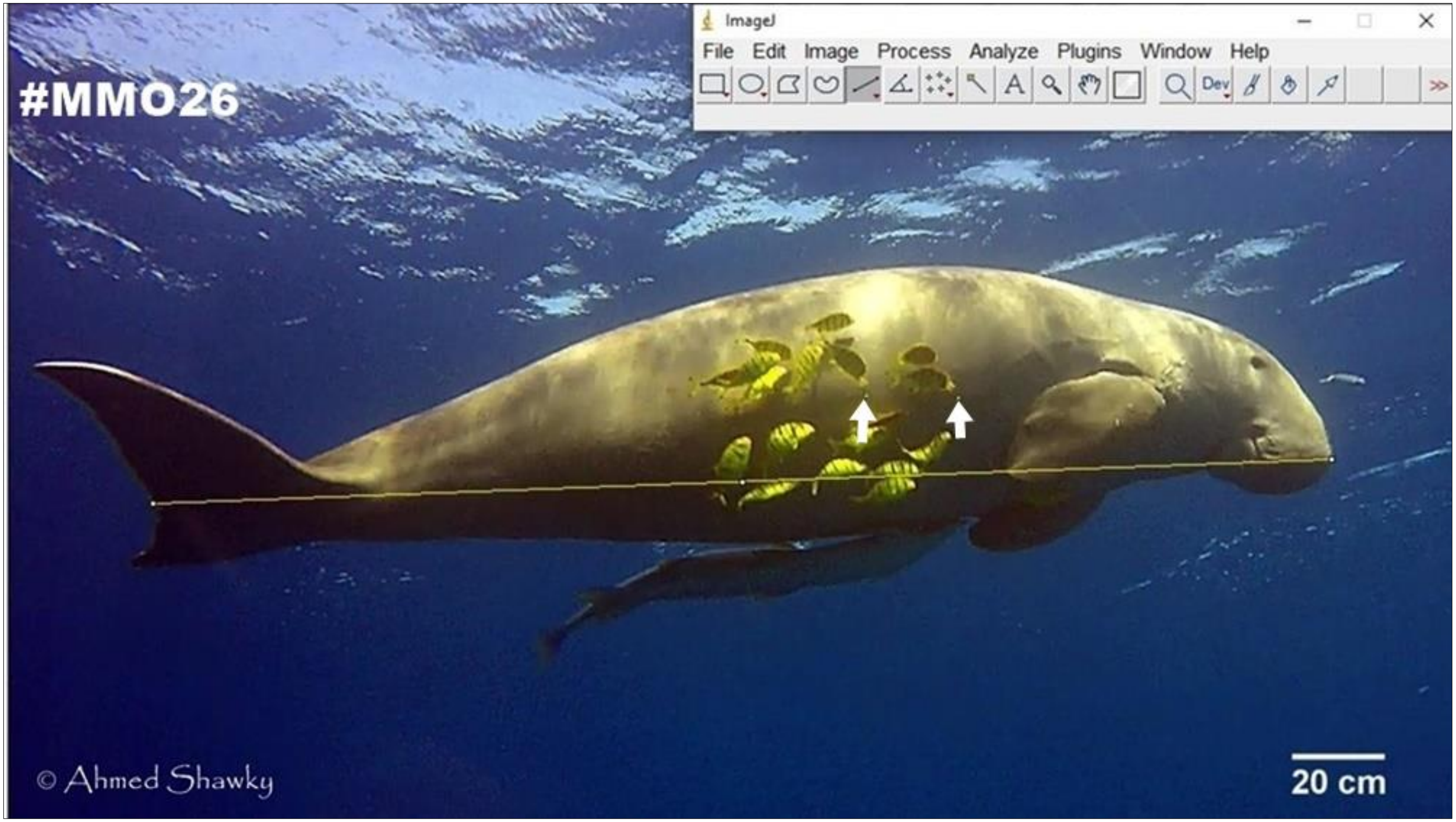


Figure 20: Measuring the total length of the dugong #MMO26 in Marsa Mobarak and the two laser dots pointed by arrows.

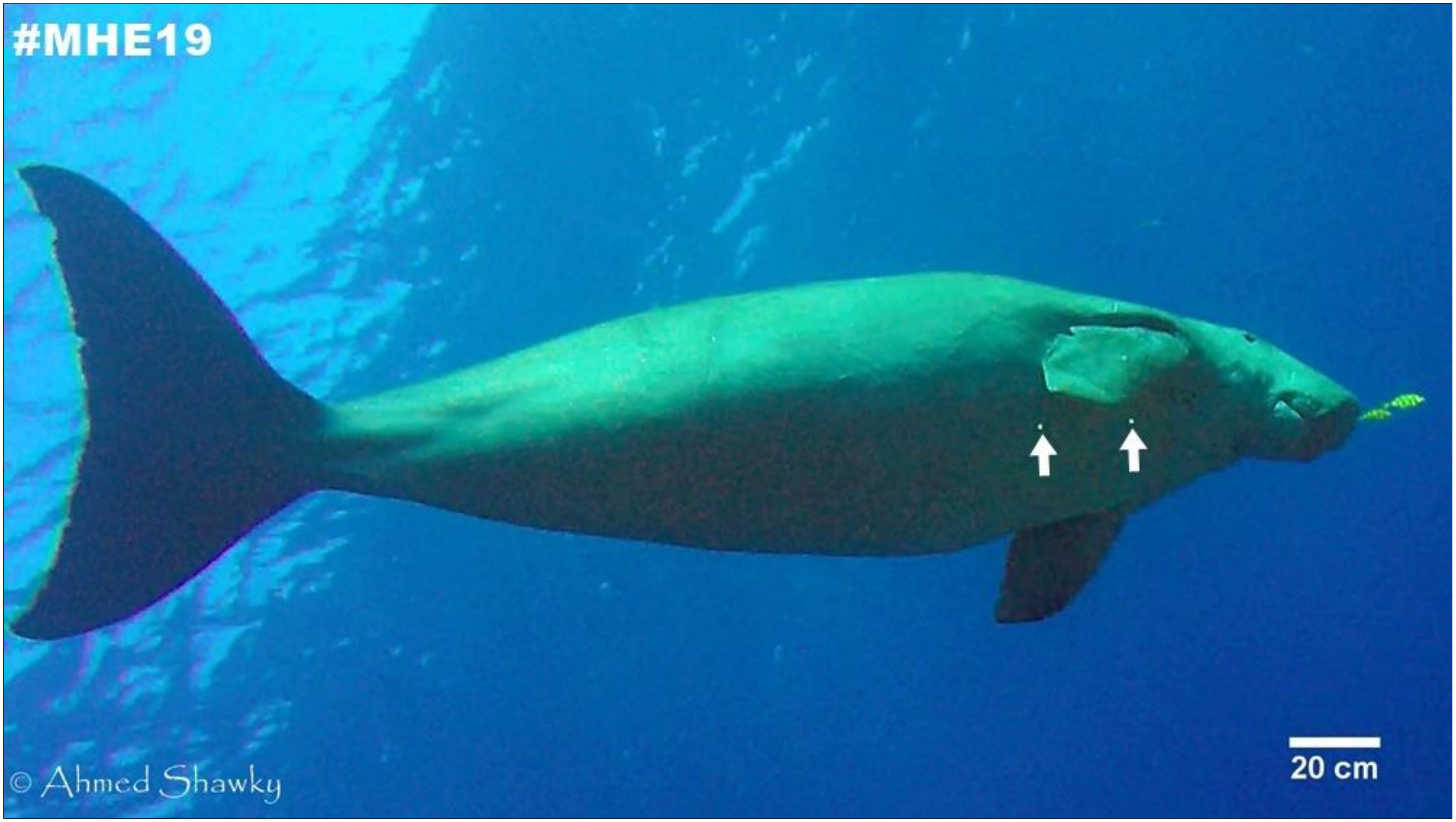


Figure 21: Measuring the total length of the dugong #MHE19 in Marsa Hermez and the two laser dots pointed by arrows.

Figure 22: Measuring the total length of the dugong #SMA31 in Sheikh Malek and the two laser dots pointed by arrows.

3.4 Modelling:

The suitable habitat is predicted in different regions along the western coast of the Egyptian Red Sea. The most habitats are in Northern Islands National Park north of Hurghada and north of Wadi El Gemal National park (Figure 23). In the deep south, other habitats are suitable for calving south of Ras Bannas and the middle coast of Elba Protected Area. More data will published later.

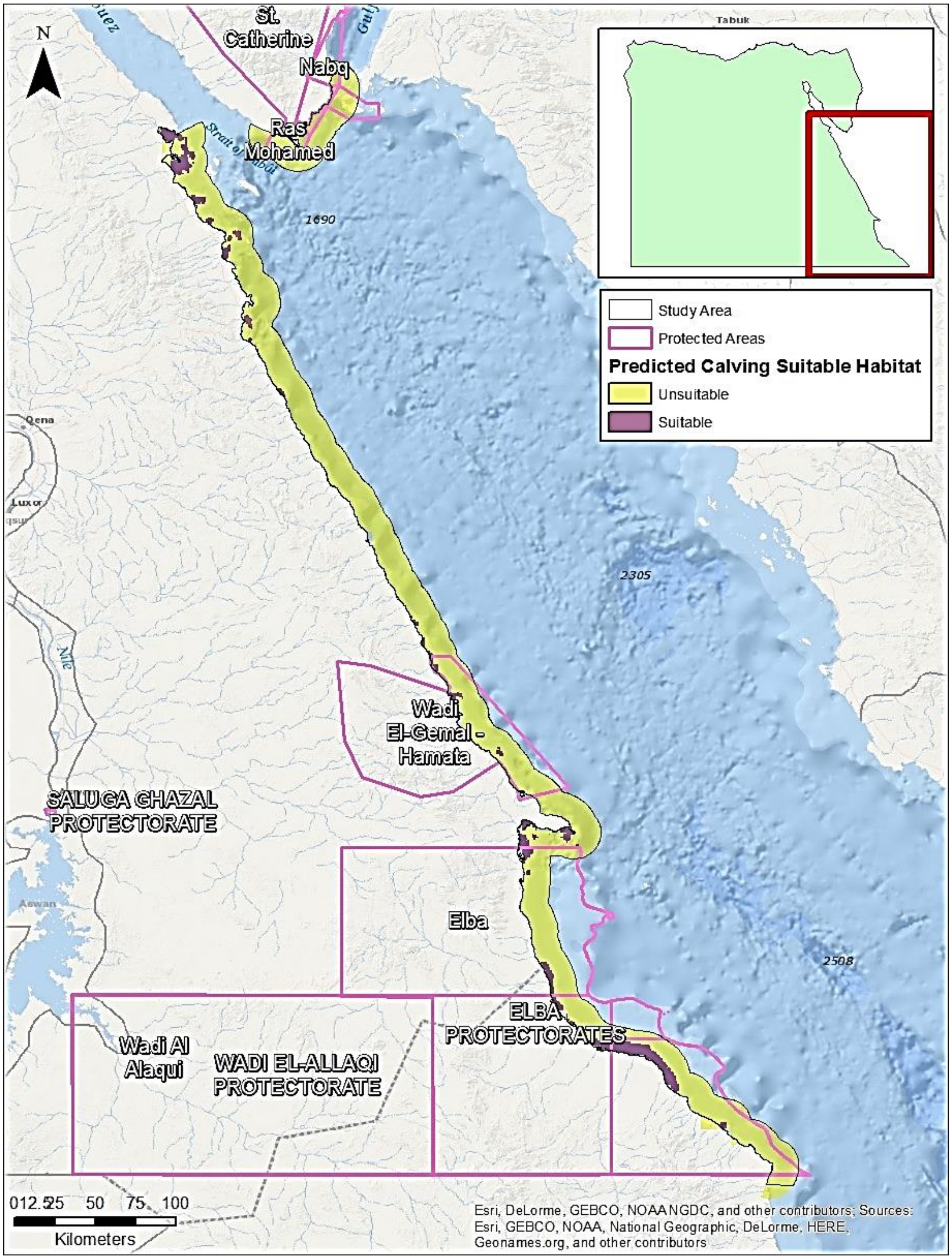


Figure 23: Predictive model for dugong calving suitable habitat.

3.5 Public awareness

Six workshops were conducted to more than 120 persons including dive and snorkel guides, managers of diving centres and tour operators and local communities (Figure 24). The project activities were presented in an event of World Wildlife Day Egypt 2019 in Cairo. Also, it was presented during the participation in an international conference located in Alexandria entitled "Coast to Ocean: Priority Actions and Investments" and Biodiversity Conference by IUCN (COP14) in Sharm El-Sheikh, Egypt. PADI Dugong Conservation Specialty Course is conducted to the guides. The divers have practiced the skills underwater by measuring the feeding trails and encountered the dugong as well by photographs. Tourists and volunteers were attended and got the knowledge of the course. More photos that document the activities are shown in Appendix 3.

Figure 24: Examples of public awareness activities.

4. Conclusion

This is the first result for the spatial and temporal variations of the feeding trails on the western coast of the Egyptian Red Sea. The data gathered confirmed that different dugong individuals with different sizes were visiting the area and varies in time and scale. This is very important for conservation the dugong habitat especially the calving area. Using the laser photogrammetry for the first time with the dugong worldwide was useful to measure the dugong body length and monitor its growth. The technique needs to continue for more different individuals to get the accurate equation for calculating the total body length from the trail width. The variation of the trail width among sites is very important for evaluating the status of these sites, especially with human activities. Our next step is to publish the data of this study in a scientific journal as well as improve the educational programs to the local community and stakeholder to understand this information which will increase the awareness for conservation. Also, a management plan for dugong conservation in the Egyptian Red Sea will be conducted.

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6. Appendix

6.1 Satellite images of the study sites.


Marsa Abou Dabbab
Image © 2019 CNES / Airbus
© 2018 ORION-ME
Image © 2019 TerraMetrics
100 m
Google earth
Imagery Date: 9/6/2018 25°20'16.56" N 34°44'26.53" E elev 2 m eye alt 366 m

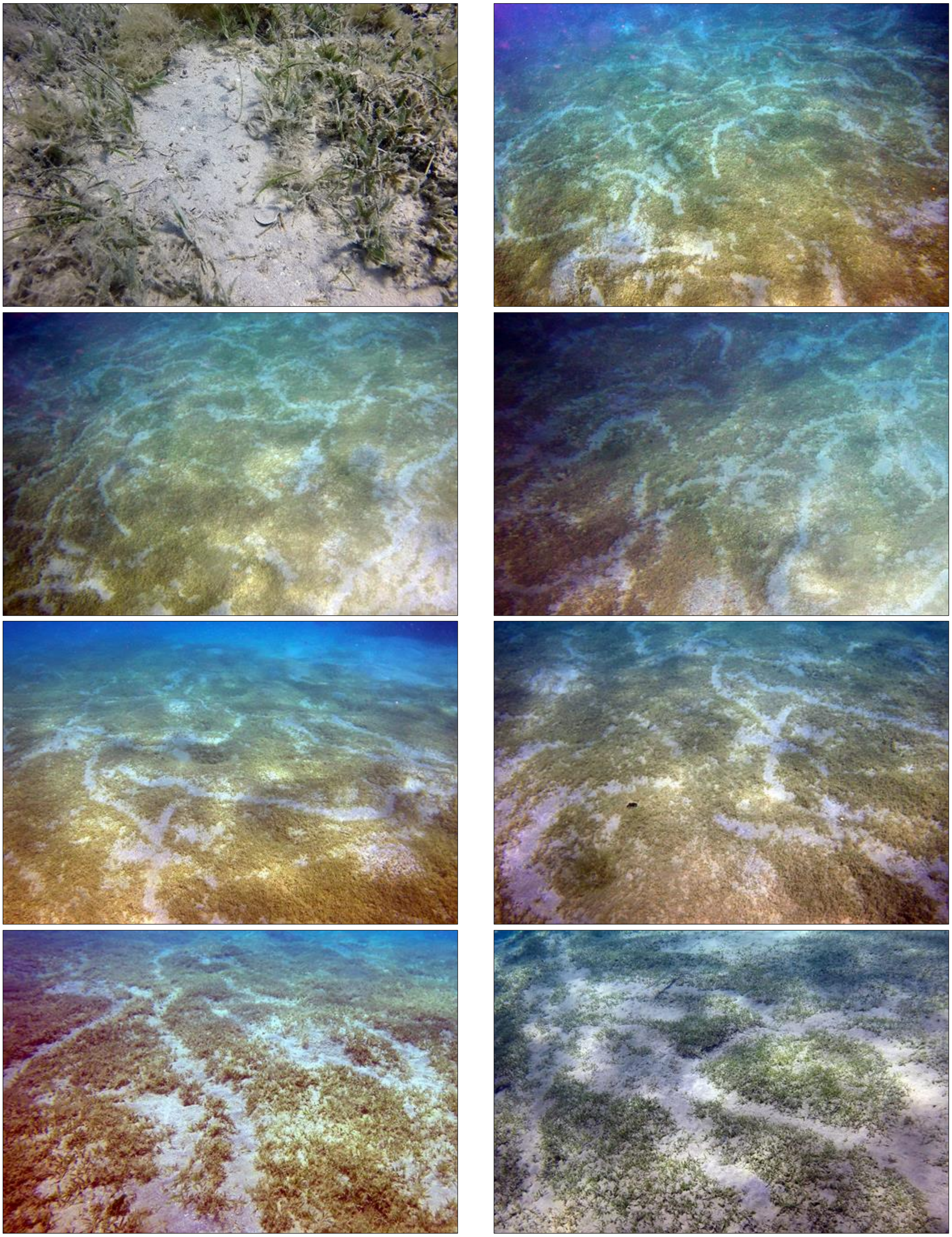

Marsa Hermez
Image © 2019 CNES / Airbus
© 2018 ORION-ME
Image © 2019 Maxar Technologies
100 m
Google earth
Imagery Date: 9/6/2018 25°19'13.24" N 34°44'45.93" E elev 0 m eye alt 385 m


Shams Alam
100 m
© 2018 ORION-ME
Image © 2019 CNES / Airbus
Google earth
Imagery Date: 7/10/2018 24°41'22.05" N 35°05'10.99" E elev 0 m eye alt 393 m

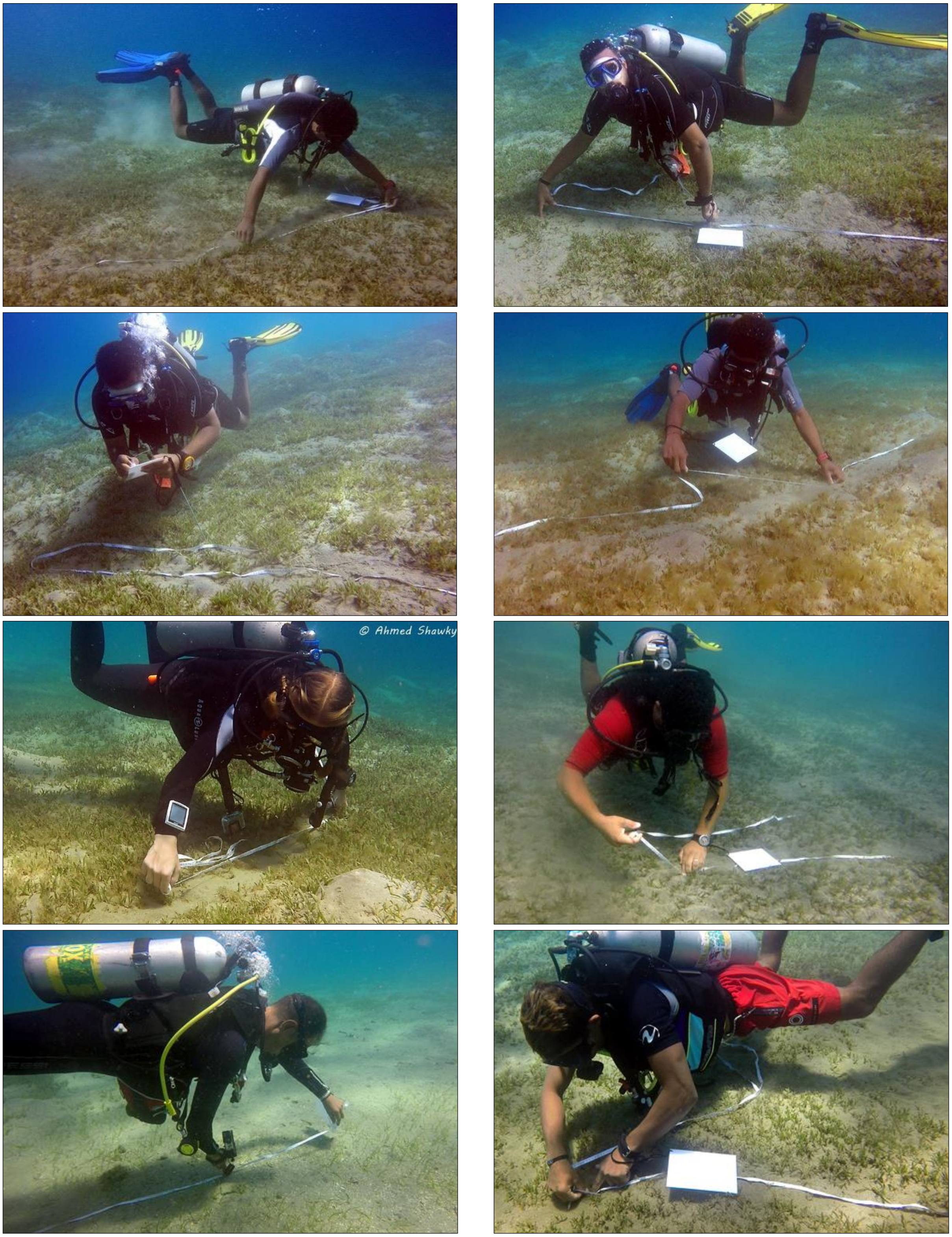

Ras Baghdady
500 m
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2018 ORION-ME
Image © 2019 CNES / Airbus
Google earth
Imagery Date: 7/10/2018 24°39'31.57" N 35°06'28.32" E elev 0 m eye alt 2.13 km


Wadi El Gemal Island
400 m
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2018 ORION-ME
Image © 2019 CNES / Airbus
Google earth
Imagery Date: 7/10/2018 24°40'00.28" N 35°09'42.46" E elev 6 m eye alt 1.28 km

6.2 Dugong feeding trails:



6.3 Measuring the feeding trails during the field survey.



6.4 Public awareness:

6.5 Dugong Conservation Divers:

PADI Temporary Card

SPECIALTY DIVER

Dugong Conservation

Name: Abdelrahman Abdelfattah Kamal
Diver No.: 1906US5831
Birth Date: 08-Sep-1992
Cert Date: 08-Jun-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

This person has satisfactorily met the standards for this certification level as set forth by PADI.This Temporary Card expires after 90 days. If you do not receive your permanent PADI certification card before this card expires, please contact your certifying instructor.

PADI Temporary Card

SPECIALTY DIVER

Dugong Conservation

Name: Alhassan Saleh
Diver No.: 1909UR7986
Birth Date: 16-Dec-1987
Cert Date: 26-Aug-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

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PADI Temporary Card

SPECIALTY DIVER

Dugong Conservation

Name: Ayman Nasr-Eldeen Morad
Diver No.: 1907UL3873
Birth Date: 09-Feb-1983
Cert Date: 18-Jul-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

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SPECIALTY DIVER

Dugong Conservation

Name: Bassam Ahmed
Diver No.: 1909UR7911
Birth Date: 23-Sep-1988
Cert Date: 26-Aug-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

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Dugong Conservation

Name: Bassam Gamal
Diver No.: 1909UR7971
Birth Date: 04-Mar-1989
Cert Date: 26-Aug-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

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Dugong Conservation

Name: Kim Saskia Hildebrandt
Diver No.: 1906UW9522
Birth Date: 17-Aug-1996
Cert Date: 11-Jun-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

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Dugong Conservation

Name: Mohamed Shazly Madany
Diver No.: 1909UR8044
Birth Date: 02-Aug-1990
Cert Date: 28-Aug-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

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SPECIALTY DIVER
Dugong Conservation

Name: MOHAMED FARED IBRAHEM
Diver No.: 1907UL3913
Birth Date: 04-Sep-1971
Cert Date: 18-Jul-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

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SPECIALTY DIVER
Dugong Conservation

Name: Mohamed Hassan
Diver No.: 1906US5868
Birth Date: 17-Aug-1991
Cert Date: 08-Jun-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

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SPECIALTY DIVER
Dugong Conservation

Name: MOHAMED HASSAN ISMAIEL
Diver No.: 1909UR8035
Birth Date: 25-Jan-1979
Cert Date: 28-Aug-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

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SPECIALTY DIVER
Dugong Conservation

Name: Michal Kowal
Diver No.: 1907UL3741
Birth Date: 15-Oct-1968
Cert Date: 18-Jul-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

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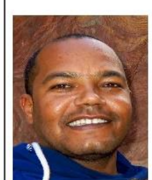
Dugong Conservation



Name: MOHAMED SALEH
Diver No.: 1909UR7812
Birth Date: 13-Oct-1979
Cert Date: 26-Aug-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

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SPECIALTY DIVER

Dugong Conservation

Name: Mohamed Shazly
Diver No.: 1906US5802
Birth Date: 21-Mar-1992
Cert Date: 08-Jun-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

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SPECIALTY DIVER

Dugong Conservation

Name: Osama Ahmed
Diver No.: 1909UR7994
Birth Date: 20-Jun-1983
Cert Date: 26-Aug-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

PADI

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PADI Temporary Card

SPECIALTY DIVER

Dugong Conservation

Name: Sandra Von Essen
Diver No.: 1909UR7846
Birth Date: 18-Jul-1992
Cert Date: 26-Aug-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

PADI

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SPECIALTY DIVER

Dugong Conservation

Name: STEFFEN BEKAAN
Diver No.: 1909UR7967
Birth Date: 24-Nov-1989
Cert Date: 26-Aug-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

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PADI Temporary Card

SPECIALTY DIVER

Dugong Conservation

Name: Tarek N. Shehabeldin
Diver No.: 1907UL3802
Birth Date: 16-Jun-1969
Cert Date: 18-Jul-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

PADI

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PADI Temporary Card

SPECIALTY DIVER

Dugong Conservation

Name: Yahia Yousef
Diver No.: 1909UR8007
Birth Date: 16-Jun-1983
Cert Date: 26-Aug-2019
Instructor Name: Ahmed Shawky
Instructor Number: 639747

PADI

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SPECIALTY DIVER

Dugong Conservation

Name: Ahmed Refaat Hamed
Diver No.: 1812UE2628
Birth Date: 01-Jan-1983
Cert Date: 07-Dec-2018
Instructor Name: Ahmed Shawky
Instructor Number: 639747

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