



*Exploring Bermuda's Exclusive Economic Zone:
studies in the Sargasso Sea*

Dr. Struan R. Smith
Curator,
Natural History Museum,
BAMZ.

29th March 2017

Abstract

A *Sargassum* sampling expedition was conducted over 100 nm the west of Bermuda over two days but no *Sargassum* was observed. The absence of *Sargassum* has been a persistent pattern around Bermuda since June 2015. Manta trawls for floating plastic marine debris detected high densities of small plastic particles (8,000-80,000 pieces per sq. km), consistent with earlier studies. A total of 43 seabirds, of at least 11 species, were observed, with the sooty shearwater and the white tailed tropic birds (longtails) were most common.

Introduction

Bermuda's Exclusive Economic Zone incorporates a large area within the Sargasso Sea. This area is inhabited by the floating *Sargassum* seaweed which hosts a unique fauna and provides a habitat and foraging opportunity for many species, such as juvenile sea turtles, flyingfishes and juvenile pelagic fishes (Coston-Clements et al, 1991). However, *Sargassum* has been conspicuously absent around Bermuda from summer of 2015 through spring of 2016. This was unexpected as *Sargassum* had invaded the Caribbean in unprecedented quantities in 2015.

The *Sargassum* community is made up of two types of brown algae species, *Sargassum natans* and *Sargassum fluitans*. But two "new" variants of these plants (*Sargassum natans XIII* and *Sargassum fluitans III*) appear to be responsible for the massive quantities of *Sargassum* observed in the Caribbean in 2015 and early 2016 (Schell et al 2015). The variants have not been reported since the 1930s (Parr, 1939), although this maybe the result of poor identification of material collected in recent years. The absence of any *Sargassum* around Bermuda for such an extended period of time, when it was so abundant at southern latitudes, could be explained by persistent patterns of ocean currents that control *Sargassum* distribution but might also reflect a limitation of these new variants to survive in the cooler waters at Bermuda's latitude.

The *Sargassum* community is threatened by many human activities including pollution, over-fishing, ship traffic, and harvesting of *Sargassum* (Laffoley et al., 2012). Plastic marine debris accumulates to very high levels in the *Sargasso Sea* (Lavender-Law et al., 2010; Eriksen et al 2015). As well, the impacts of global climate change and ocean acidification could pose a threat to this community. A recent study on calcifying animals living on *Sargassum* around Bermuda today showed some decline in their patterns of abundance compared to historic

samples from the 1970s (Choyce, 2016). The recent study by Huffard et al. (2014) shows that there may actually be some changes in the associated species composition that have occurred within the *Sargassum* community since the 1970s. These results accord with other recent observations made around Bermuda (Grenfell and Smith, 2012; Wight and Smith, 2013; Harrigan, 2013; Witzak and Smith 2014, Smith et al, 2016) which also found similar trends and patterns, with significantly larger shrimp populations, while some crabs have diminished.

There are efforts to help protect this community and spread awareness through projects like <http://www.sargassoseacommission.org>. Only Bermuda has jurisdiction over a significant portion of the Sargasso Sea to help with conservation efforts within its Exclusive Economic Zone (Trott et al., 2010; Laffoley et al., 2012). In order to effectively conserve the *Sargassum* community we must first understand the biology and ecology of this ecosystem to determine what factors may be changing the composition of the community.

This study is aimed to collect *Sargassum* to study the diversity and abundance of attached and mobile invertebrates associated with the *Sargassum* found around Bermuda. An assessment of plastic debris associated with *Sargassum* and also floating on the ocean surface were made. Observations of sea birds were also recorded. This study is part of an ongoing project, conducted in the same month each year, extending back to 2013, and this allows for detailed comparisons between years, to determine changes or differences compared to recent and historical samples.

Methods

Sampling for this study occurred on the *S/V Sea Dragon* in offshore waters from May 13th to May 15th and samples were collected on a route passing Challenger Bank that extended about 100 nm W of Bermuda (Fig 1.).

An effort was made to collect *Sargassum* but none was observed on during the cruise. In the first part of the cruise, on the afternoon of May 13th, we observed very high densities of the Portuguese Man O' War (*Physalia physalia*) and the By-the-Wind Sailor (*Velella velella*) and a great abundance of a gelatinous spherical plankter. Slicks of the organisms, along with plastic marine debris were very conspicuous for over 40 nm. These slicks had accumulated because of the relatively low wind conditions. On the following days (May 14/15) winds increased significantly and disperse these organisms.

Surface plastic marine debris

Two surface manta trawls were collected on the *Sea Dragon* cruise on May 13th from 32° 08.2308N; 64° 58.2468 to 32° 07.3440, 65° 00.0566 from 15:42 PM to 15:44 PM and again on May 14th from 32° 06.5536; 67° 02.8502 to 32° 06.9616, 67° 05.333 from 9:50 AM to 10:55 AM. Each manta trawl was conducted for 1 hour at a speed of ~2 knots. The samples were examined for plastic debris and the numbers of plastic particles counted. The number of floating plastic pieces within 20m of *Sea Dragon* on one side of the vessel were also recorded on the cruises.

Seabird observations

A watch was maintained for sea birds at all times and each seabird observed was identified to the lowest possible taxonomic level, based on the quality of the observation (distance from the vessel, duration of observation, flight character, plumage characteristics). Paul Watson and Eric Hetzel of the Bermuda Audubon Society made the bulk of the observations.

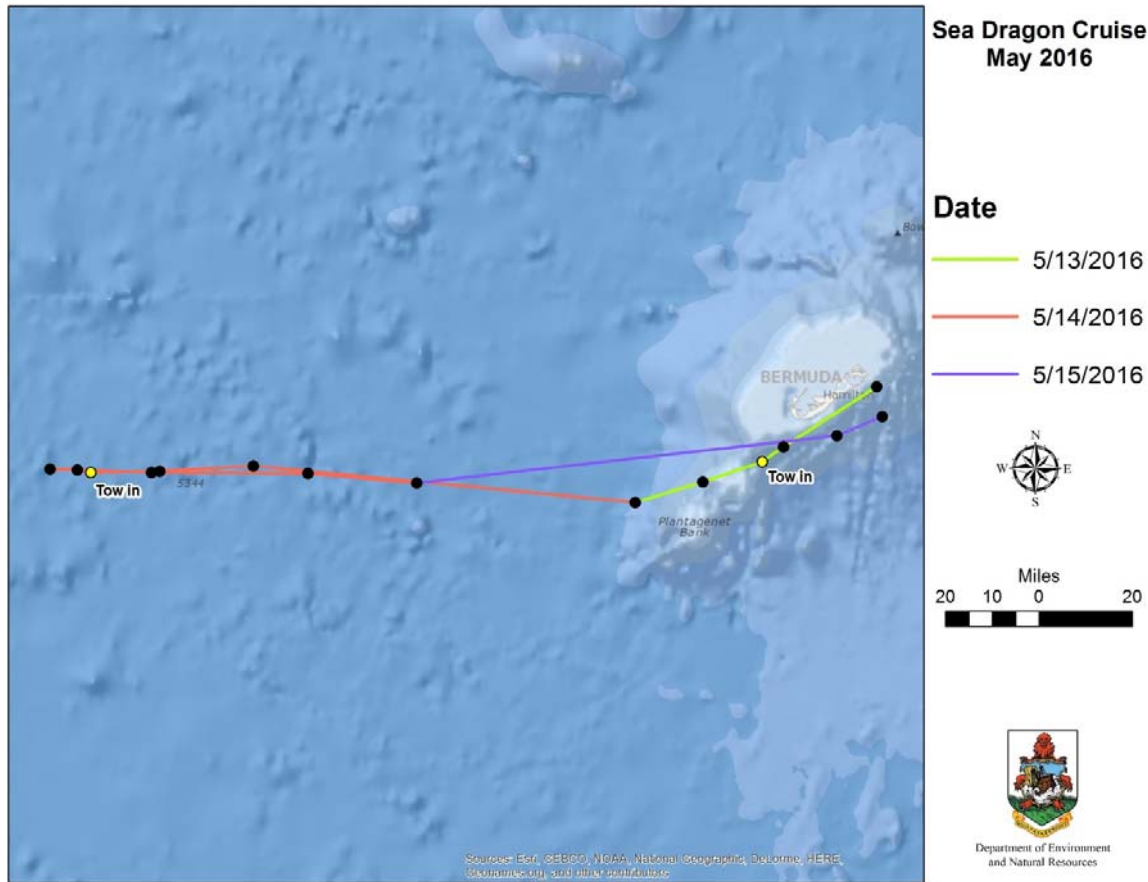


Figure 1. Cruise track of the S/V *Sea Dragon*, May 13th to May 15th 2016. Locations of the start of the manta tows are indicated with the yellow dots.

Manta trawl samples

The manta trawl in the afternoon of May 13th captured 182 pieces of plastic marine debris, the majority less than 4mm in size, after a 1 hour trawl, covering an area of about 0.00225 sq. km. This equates to ~80,550 pieces of plastic per sq. km. The morning trawl on May 14th captured 19 pieces of plastic marine debris after a 1 hour trawl, covering an area of about 0.00225 sq. km. This equates to ~8,400 pieces of plastic per sq. km. These values are consistent with previous samples from 2014 and 2015 (Fig. 2).

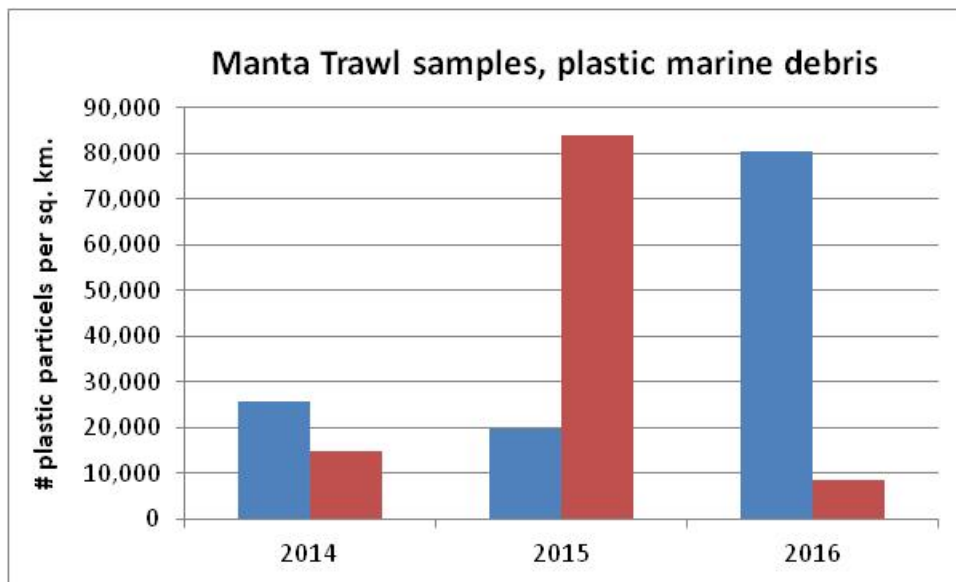


Figure 2. Summary of manta tow samples taken on current and previous *S/V Sea Dragon* cruises (2nd and 3rd June, 2014; 5th and 6th June, 2015). Each bar represents a different tow.

Visible plastic marine debris

The calm conditions on the afternoon of 13th May facilitated observations of visible plastic marine debris as the vessel moved through the water at 5-8 knots, with seas less than 0.5m. Stormy weather and sea state (1-2 m) on the 14th and 15th of June restricted our ability to observe floating marine debris. Although sea state was not very high the presence of white caps and sea foam made it difficult to observe the smaller pieces of floating plastic (Table 1)

Previous observations from other *Sea Dragon* voyages, in 2014 and 2015, under calm to moderate conditions did not show very high densities of plastic marine debris compare to the densities observed in the afternoon of 13th May (Table 1).

Table 1. Visible plastic marine debris observed on one side of the vessel, within 20m, while underway. Various observers kept watch and reported what they could see and estimated size class of the material.

	2014		2015		2016		
	2nd June PM 13:00 - 17:00	5th June PM 14:00 - 17:00	6 June AM 06:00-12:00	6 June PM 13:00-18:00	13th May PM 13:00 - 18:00	14th May AM 06:00-12:00	14th May PM 13:00-17:30
Sea state	0.5 -1 m	1 m	1 m	1 m	0.5 - 1 m	1 - 1.5 m	1.5 - 2 m
Object or Type							
Buckets	1					1	
Float with radar reflector	1						
Plastic bottles	1					1	
Very large fragments, ropes, >1 m					2		
Large plastic fragment, 20 cm-1 m	4	2			8		1
Med plastic fragment, 10-20 cm	1				2		
Small plastic fragment, 5-10 cm		1			6	1	
Very small plastic fragment, 1-5 cm		1		1	11		
Very very small plastic fragment, <1 cm					14	1	
Total	8	4	0	1	43	4	1

Sea Bird observations

Paul Watson prepared a summary of his observations and it is inserted below:

“Once offshore we headed off from Spit buoy in a SW direction to clear the South shore reef, as expected large numbers of **White tailed tropicbird** (longtail) were seen throughout the transit of the South shore of Bermuda.

The first pelagic birds were seen at 1220 about 2.5 NM S off Spittal Pond in the form of a nice (but distant) **Cory’s Shearwater** a species which breeds in the Azores, Madeira, Canary and Cape Verde islands as well as the Mediterranean, this was followed by another 30 minutes later.

Later in the afternoon 3 miles South of Pompano a large Skua/Jaeger was seen but was unfortunately too distant to confirm the actual ID.

An obliging if somewhat late **Humpback whale** gave fair if not too distant views shortly after and surprisingly was the only cetacean seen on the trip.

This was followed by a **Greater Shearwater**, a Southern Atlantic Ocean breeder from Tristan da Cunha, Gough, Inaccessible and Nightingale island, that breeding between late Septmeber and depart April and head into and circumnavigate the North Atlantic feeding, before returning t o the southern ocean to breed. This bird can be seen in large numbers off Bermuda between May and Mid July.

Next was a nice **Arctic tern**, another long distance migrant and believed to be a bird species which sees the most daylight in its lifetime migrating between the Arctic in the summer to breed and the Antarctic in the Northern winter to spend foraging for food in the southern summer. All of the Arctic terns seen were on a ‘mission’ and headed due North for their breeding grounds never stopping or slowing to look at the boat. Moments later the large and menacing **Pomarine**

Jaeger headed toward the boat allowing good views at around 100 metres showing the twisted spoon tail and 'light phase' plumage. This species has 3 plumage phases making ID confusing, and breeds in the northern latitudes up to the edge of the Arctic, and in our winter can migrate as far south as the tip of Africa and South America. A Longtail was seen 16 Miles to the SW heading offshore to feed, followed shortly thereafter by our first **Sooty Shearwater** a species which breeds in the islands around the Tip of South America as well as around New Zealand and migrates into the North Atlantic as well as Pacific.

This was followed 20 minutes later by our first **Leach's Storm petrel**, a small black and white seabird which breeds in Northern latitudes in both the Pacific and Atlantic (Maine through to Newfoundland and Greenland, as well as northern Europe) and migrates into the tropics in winter, and a second **Greater Shearwater**. Then a pair of **Leach's storm petrels** flew in close to the boat allowing good views.

The day was drawing to a close and just before sunset a medium large tern was seen about ¼ mile away, we watched the bird for about 2 minutes and every species of tern went through my mind the bird was dark above and pale below and appeared to be grey in the rump area, Robbie Smith casually mentioned 'Sooty tern' and the light bulb clicked. This was either an adult **Sooty** or **Bridled tern**, watching the flight profile and trying to clinch finer ID points did not help so it went down as either/or species. Both species breed throughout the tropics and are fairly common in the Caribbean.

14th May: first light had the boat around 65 miles West of Bermuda and started with **Sooty Shearwater** and a **White tailed tropicbird**, which was sitting on the ocean.

At 7:45 AM a medium sized storm petrel approached the boat very close and the size, structure and flight was immediately recognizable as **Band Rumped Storm Petrel**, a bird which was only first seen in Bermuda Waters in 2013 and Atlantic birds hail from Azores, Madeira, Cape Verde, Ascension and St Helena. The bird turned allowing great views of the rump and showed no 'toe projection' discounting Wilson's Storm petrel, a smaller but similar species. Eric unfortunately missed this bird as he was below decks sleeping. Eric and the rest of the boat were rudely awakened shortly after by the shout of "**South Polar Skua**", and our first encounter of the trip of this (as its name implies) Skua which breeds around the Antarctic edge and Antarctic Peninsula, and migrates into the North Atlantic in our summer.

The day continued with **Sooty Shearwater**, and both **Leach's** and our first **Wilson's Storm petrel**. A circumpolar Antarctic and sub-Antarctic islands breeder and believed to be one of the most prolific birds (in numbers) in the world, however as it spends all its life on the ocean, it is seen by few people.

Unfortunately, we had made it about 100 Miles West of Bermuda but had to U turn and head for home in within our allotted time frame around 12PM, two more **Sooty Shearwaters** flew close

by the boat, but the weather was not to cooperate and wind and rain caused those not on 'watch' to remain below decks thoroughly dejected with the deluge.

By 6PM the rain had stopped and birding resumed with an obliging **Arctic tern** heading north , and then our second **Wilson's Storm petrel** and second **South Polar Skua**. The birds were few and far between and the day ended with a **Sooty Shearwater**, as we raced back to Bermuda Overnight in Moderate to Strong winds.

Sunday 15th May: Started with thunder and Lightning before dawn as we approached the west of Bermuda and between thunder storms, an **Arctic tern** flew north using the strong south winds as a push.

4 Sooty Shearwater and **9 White tailed tropicbird** (longtail) all heading offshore, were our South shore escorts as we transited around 3-8 miles offshore. “

Fig 2: Wilson's Storm Petrel (L) and South Polar Skua (R). Photos: Paul Watson



Species List

White tailed tropicbird. Good numbers seen including several offshore.

Pomarine Jaeger: A light phase bird seen at 32 07.352N 065 00.061W, at 1640 hrs on 13th May

South Polar Skua: Seen at 32 06.737 N 066 50.064W at 0815 hrs and at 32 06.393N 066 22.574W at 1850 hrs on 14th May.

Cory's Shearwater: 2 birds seen ~2.5 nm S of Spittal Pond at 1220 and 1250 hrs, 13th May.

Greater Shearwater: 2 birds seen. 1st at 32 08.130N at 1605 on 13th May and 2nd at 1905hrs on 13th at 32 30.852N 065 14.835W.

Sooty Shearwater: 12 birds seen in total. 1845 hrs. 13th May at 32 30.852N 065 14.835W. 14th May. 0615 hrs. 32 07.539N 066 32.692W, 0900 hrs 2 birds 0910 hrs, 1 bird 32 06.741N 066 50.989W, birds at 1210 and 1213 hrs. 32 07.054N 067 10.253W 1954 hrs., 32 06.393N 066 22.574W. 15th May. 4 birds seen whilst transiting South shore, ~2-8 miles offshore.

Leach's Storm Petrel: Birds seen at 1905 and 1940 hrs. (2 birds) at 32 02.154N 065 20.627W on 13th May and at 1000 hrs. on 14th May at 32 06.989N 066 55.231W.

Wilson's Storm Petrel: birds seen at 1010 hrs. at 32 06.989N 066 55.231W and at 1850 hrs. at 32 06.393N 066 22.574W on 14th May.

Band -Rumped Storm petrel: 1 bird afforded close views at 0745 hrs. on 14th May at position 32 06.737N 066 50.064W.

Arctic Tern: total of 3 birds seen. 13th May. 1630 hrs. at 32 07.543N 064 59.677W. 14th May. 1800 hrs. at 32 06.393N 066 22.574W. 15th May. 0710 hrs. at 32 12.313N 064 44.461W.

Sooty/Bridled tern: an adult of either of these species (not specifically identified) was seen at 1947 hrs on 13th May at 32 01.830N 065 21.736W and was likely bridled as rump area appeared lighter grey then back.

Table 2. Seabirds observed on the cruise, tabulated from Paul Watson and Robbie Smith records

	13-May-16	14-May-16	15-May-16	
<i>Duration of observations</i>	PM	AM/PM	AM	
<i>Distance from Bermuda</i>	15 nm SW	60-100 nm W	10 nm SW	Totals
Species	#observ.	#observ.	#observ.	#observ.
Greater shearwater	2	0	0	2
Sooty shearwater	1	6	4	11
Corey's shearwater	2	0	0	2
Longtail	1	1	11	13
Pomarine jaeger	1	0	0	1
Unident. jaeger	1	0	0	1
South Polar skua	0	2	0	2
Wilson's Storm petrel	0	2	0	2
Leach's Storm petrel	2	1	0	3
Band-rumped Storm petrel	0	1	0	1
Unident. Storm petrel	1	0	0	1
Arctic tern	1	1	1	3
Sooty tern	1	0	0	1
Totals	13	14	16	43

Thus, a total of 43 birds of at least 11 species were recorded with the Longtail (White tailed tropicbird) and Sooty shearwater the most common species. These results are similar to previous observations made on earlier cruises (Table 3), although far fewer Greater Shearwaters were observed and this may be due to an earlier cruise time on May, compared to the prior cruises in early June. The consistent observations of longtails up to 150nm from Bermuda may indicate the extent of their daily foraging range from Bermuda to support their nestlings.

Table 3 Summary of seabird observations on Sea Dragon cruises in 2013, 2014, 2015 and 2016. Observations made through constant vigilance by crew of passing birds.

	1-Jun-13	2-Jun-13	3-Jun-13	4-Jun-13	5-Jun-13	2-Jun-14	3-Jun-14	5-Jun-15	6-Jun-15	9-Jun-15	13-May-16	14-May-16	15-May-16	Totals
<i>Duration of observations</i>	PM	AM/PM	AM/PM	AM/PM	AM/PM	PM	AM/PM	PM	AM/PM	PM	PM	AM/PM	AM	
<i>Distance from Bermuda</i>	10-50nm S	60-150nm S	170nm S	120-100nm S	80-25nm S	10-40 nm SW	10-25 nm SW	5-20 nm S	25-80 nm SW	10 nm S	15 nm SW	60-100 nm W	10 nm SW	
Species	#observ.	#observ.	#observ.	#observ.	#observ.	#observ.	#observ.	#observ.	#observ.	#observ.	#observ.	#observ.	#observ.	#observ.
Greater shearwater	10	10	6	10	14	0	0	6	9	7	2	0	0	74
Sooty shearwater	3	1	0	0	0	0	0	0	1	0	1	6	4	16
Corey's shearwater	2	1	4	5	9	0	0	0	0	0	2	0	0	23
Unident. Shearwater	0	0	1	1	3	0	2	1	1	0	0	0	0	9
longtail	9	9	2	6	9	3	6	2	10	1	1	1	11	70
Red-billed tropic bird	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Pomarine jaeger	2	2	3	1	1	0	0	0	0	0	1	0	0	10
Unident. jaeger	0	0	1	0	0	0	0	0	0	0	1	0	0	2
South Polar skua	0	2	0	1	1	0	0	0	0	0	0	2	0	6
Wilson's Storm petrel	0	2	1	1	3	1	3	0	0	0	0	2	0	13
Leach's Storm petrel	0	0	0	3	0	0	0	0	0	1	2	1	0	7
Band-rumped Storm petrel	0	0	0	0	1	0	0	0	0	0	0	1	0	2
Unident. Storm petrel	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Masked Booby	0	0	0	0	2	0	0	0	0	0	0	0	0	2
Tern, forked tail, black ca	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Arctic tern	0	0	0	0	0	0	0	0	0	0	1	1	1	3
Sooty tern	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Unident. birds	0	0	0	0	0	0	0	0	2	0	0	0	0	2
Totals	26	28	18	28	43	4	11	9	21	9	13	14	16	243

Acknowledgements

I would like to thank the Atlantic Conservation Partnership and the Bermuda Zoological Society for providing the funds for the charter of *S/V Sea Dragon*. I would like to thank the volunteer crew: Amy Harvey (Bermuda College) and her students Jayde Curtis and Coby Ferreira, JD Symonds (U of Tampa), Paul Watson and Eric Hetzel (Bermuda Audubon Society) and Kyla Smith (BIOS). Captains Eric Loss and Shanley McEntee and crew Katie Jewett, provided great support for our team. Mandy Shailer (DENR) prepared the cruise track map.



Stalwart crew safely back in St. George's Harbour after a stormy night at sea

References

- Choyce, J., 2016. Trends in the decadal and seasonal variation in the calcifying epiphytic species in the Sargassum community around Bermuda. Master's Thesis paper, University College of London. 22 pp.
- Coston-Clements, L., Settle, L.R., Hoss, D.E. and F.A. Cross, 1991. Utilization of the Sargassum habitat by marine invertebrates and vertebrates- a review. NOAA Technical Memorandum. NMFSSSEFSC-296, 30 pp.

- Eriksen, M., L.C.M. Lebreton, H.C. Carson, M. Thiel, C.J. Moore, J.C. Borerro, F. Galgani, P.G. Ryan, J Reisser, 2014. Plastic pollution in the world's oceans: more than 5 trillion plastic pieces weighing over 250,000 tons afloat at sea. PLoS ONE 9(12); e111913
- Grenfell, C. and S. R. Smith, 2012. Spirit of Bermuda Research Cruise in the Sargasso Sea. Natural History Museum report. BAMZ. 7pp
- Harrigan, R. 2013. Species diversity and abundance associated with near-shore and offshore Sargassum spp. near Bermuda. U. Rhode Island and BIOS Fall Semester project report, 18pp.
- Huffard, C.L., von Thun, S., Sherman, A.D., Sealey, K., and K.L. Smith, Jr., 2014. Pelagic *Sargassum* community change over a 40 year period: temporal and spatial variability. Marine Biology. DOI 10.1007/s00227-014-2539y.
- Laffoley, D. d'A et al., 2012. The protection and management of the Sargasso Sea: The golden floating rainforest of the Atlantic Ocean. Summary Science and Supporting Evidence Case. Sargasso Sea Alliance. , 44 pp.
- Lavender-Law, K., Moret-Ferguson, S., Maximenko, N.A., Proskurowski, G., Peacock, E.E., Hafner, J. and C.M. Reddy, 2010. Plastic accumulation in the North Atlantic Gyre. Science: 239, 1185-1188.
- Parr, A., 1939. Quantitative observations on pelagic *Sargassum*. Vegetation of the Western North Atlantic. Bull. of Bingham Oceanographic Collection, Vol VI, part 7. Peabody Museum of Natural History, Yale University. 93 pp
- Schell, J.M., D.S. Goodwin, A.N.S. Siuda, 2015. Recent *Sargassum* inundation events in the Caribbean: Shipboard observations reveal dominance of a previously rare form. Oceanography 28; 8-10
- Smith, S. R., M. R. Hall, S. Beland, 2016. *Sargassum* community studies near Bermuda, 2015.
- Trott, T.M., McKenna, S.A., Pitt, J.M. Ming, F.W., Rouja, P., Gjerde, K.M., Causey, B, Earle, S.A. 2010. Efforts to enhance the protection of the Sargasso Sea. Proc. 63rd, Gulf. Caribb. Fish. Instit., San Juan. P.R., pp 282-286
- Wight, S. and S. R. Smith, 2013. The voyage of the *Sea Dragon*: a study of species diversity in the *Sargassum* community in the Sargasso Sea around Bermuda. Natural History Museum report. BAMZ. 17pp.
- Witczak, D. and S. R. Smith, 2014. *Sargassum* studies near Bermuda. BAMZ# 2794. 18 pp.