Literature Synthesis

Ecological Services Provided by Floating *Sargassum*: A synthesis of quantitative data in the scientific literature

DWH NRDA Water Column Technical Working Group Report

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For Industrial Economics, Inc.

February 6, 2012

Draft 2.1

DWH-AR0294583

Purpose and Scope: At the request of National Oceanic and Atmospheric Administration (NOAA) and the Trustee's Fish Technical Working Group (TWG), a synthesis of the available literature on ecological services provided by pelagic *Sargassum* was conducted in the Fall of 2011. The primary purpose of this synthesis was to provide background information on the life history of *Sargassum*, identify data sets that provide quantitative estimates of fish and invertebrate abundance as well as other ecosystem services and identify literature on oil toxicity of *Sargassum*. The Literature synthesis was compiled by Sean Powers and Andrea Kroetz under contract from Industrial Economics, Inc.

Background

A key oceanic habitat that was impacted by the *Deepwater Horizon* Oil Spill is floating *Sargassum* mats. *Sargassum* mats in the Gulf of Mexico (GOM) are formed by the convergence and aggregation of two species of brown algae: *Sargassum natans* and/or *S. fluitans*. The pelagic mats of brown algae form an oasis of structure in the open ocean that supports a large and diverse assemblage of marine fish and invertebrates. Because *Sargassum* clumps and mats are found in the neuston (floating surface layer of organisms), these habitats and associated fauna are at potential risk of exposure to surface oil, sheens, and chemical dispersants introduced as a result of the MC 252 Incident. Co-occurrence of *Sargassum* mats and surface oil were documented during the summer of 2010 in the northcentral GOM (Figures 1 and 2). Strip transect flown by an NSF supported project reported several locations of overlap during the summer (Figure 3). Given that floating *Sargassum* plants may live for two years or more and the northern GOM may be an important nursery for the algae, the effects of the MC 252 Incident may be far reaching and recovery of this habitat may be prolonged. The loss and degradation of other structurally complex brown algae (*Fucus* and *Laminaria,* kelp) in Prince William Sound, Alaska following the *Exxon Valdez* oil spill demonstrates the potential negative consequences of loss of structurally important brown algae.

Figure 1. Oiled *Sargassum* observed during summer 2010 (Source: Powers and Hernandez, NSF supported project).

Figure 2. Tarballs and oil floating among *Sargassum* clumps (above); neuston net codend after sampling *Sargassum* habitats during summer 2010 (Source: Powers and Hernandez, NSF supported project).

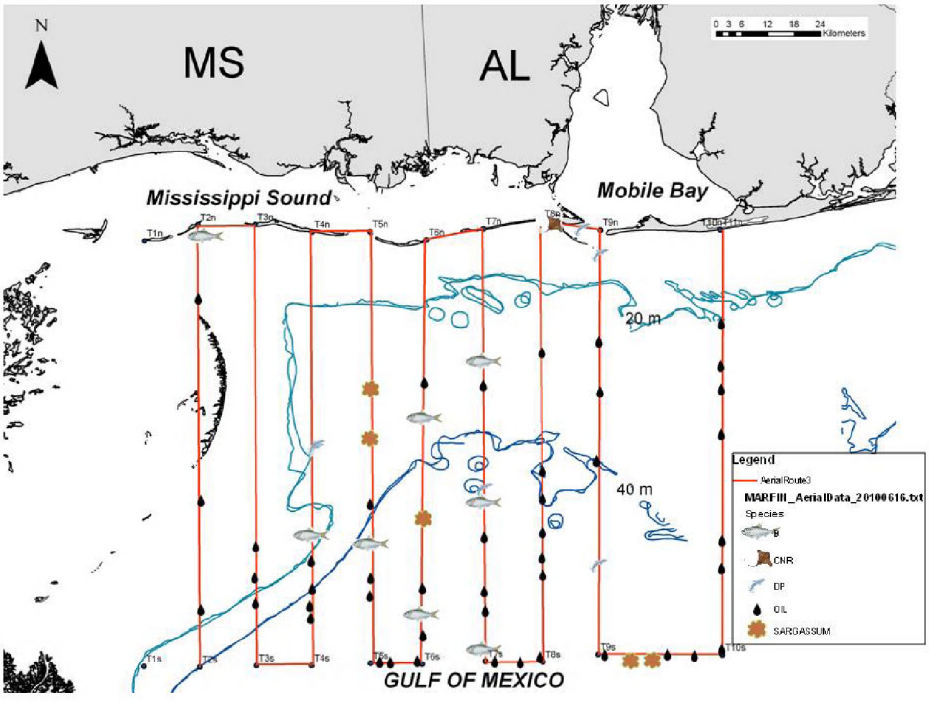

Figure 3. Results of one (6/10/2010) of eight aerial surveys conducted during the summer of 2010 documenting oil presence (indicated by oil droplets), *Sargassum*, and various fish schools (fish icon).

In this document, we review the general life history of pelagic *Sargassum* species in the GOM and North Atlantic, the spatial and temporal distribution of the habitat, the ecosystem services provided by floating *Sargassum* and summarize the quantitative data on the fish and invertebrate abundance in *Sargassum.* Finally, we review the limited information on oil co-occurrence with and toxicity to pelagic *Sargassum.*

Literature Review Objectives and Methodology

To assess the importance of floating Sargassum, we conducted a literature review, synthesis and quantitative analysis of faunal densities. The primary objectives of the review were to: (1) gather available literature on life history and spatial and temporal distribution of pelagic Sargassum, (2) identify and synthesize studies that included faunal densities associated with floating Sargassum in the GOM and North Atlantic, and (3) collect available literature describing acute and chronic effects of oil and dispersant exposure to *Sargassum* and as well as other brow algae in the GOM and North Atlantic.

Relevant literature was identified by using standardized search criteria and querying Google Scholar, Scopus and ScienceDirect search engines. Each search engine query included three terms. The first term was the specific habitat of interest (Sargassum, Phaeophyceae) and was varied to include multiple common names (e.g. floating Sargassum, Gulf weed, brown algae, floating seaweed, etc.). The second term was the geographic region of interest (GOM, Atlantic Ocean, Sargasso Sea, Alabama, Florida, etc.). The third term was used to identify the studies that focused on a taxonomic group or other specific objectives within the scope of the review (e.g. fish, invertebrates, birds, turtles, oil, dispersants, etc.). Search results were reviewed and relevant studies were exported into an Endnote X4 literature database. From the search engine queries, more than 500 unique references were acquired from the above three search criteria and approximately 130 of these were relevant to the review objectives. The literature cited sections of the most relevant studies were examined for additional sources that were not acquired by the Scopus, ScienceDirect or Google Scholar search engines.

Life history, distribution and ecology of pelagic *Sargassum*

There are several species of the brown algae *Sargassum* that range from benthic, sessile forms to free floating species. In the north Atlantic, *Sargassum natans* and *Sargassum fluitans* are the most abundant forms with *S. natans* comprising up to 90% of the total drift macroalgae in the Sargasso Sea (SAFMC 2002). These pelagic species are typically gold-brown in color and range from 20-80 cm in diameter (SAFMC 2002). Most pelagic *Sargassum* circulates between 20°N and 40°N latitudes and 30°W longitude and the western edge of the Florida Current/Gulf Stream. The greatest concentrations are found within the North Atlantic Central Gyre in the Sargasso Sea (Winge, 1923; Parr, 1939; Dooley, 1972; Butler et al., 1983; Butler and Stoner, 1984). Total biomass is unknown, but, estimates obtained from net tows range from 800 – 2,000 kg wet weight km^{-2}; within the Sargasso Sea, this translates into a standing crop of 4 to 11 million metric tons (Parr 1939; Zaitzev 1971; Peres 1982; Butler et al. 1983; Butler and Stoner 1984). *Sargassum* seems to exhibit seasonal patterns (2002-2008) in which it originates in the northwest GOM in the spring of each year and then it is advected to the Atlantic Ocean. *Sargassum* appears off Cape Hatteras in July and then ends up northeast of the Bahamas the following February (Gower and King 2011).

Although life-span for pelagic *Sargassum* is difficult to assess, estimates of life span of one to an upper bounds of three years (based on non-floating *Sargassum* species, e.g., *Sargassum muticum*) have been reported. *S. natans* and *S. fluitans* propagate primarily, and possibly exclusively, by vegetative fragmentation while other *Sargassum* species reproduce via propagules (SAFMC 2002; Kendrick and Walker 1995). Gower and King (2008) reported the primary "nursery area" for *Sargassum* is the northwest GOM (Gower and King 2008). As Sargassum ages, the plant darkens and the fronds become heavily encrusted with myriad life forms. As the fronds grow heavier from encrusting animals, density exceeds the buoyancy provided by the *Sargassum*'s gas bladders, and the alga may be more susceptible to sinking.

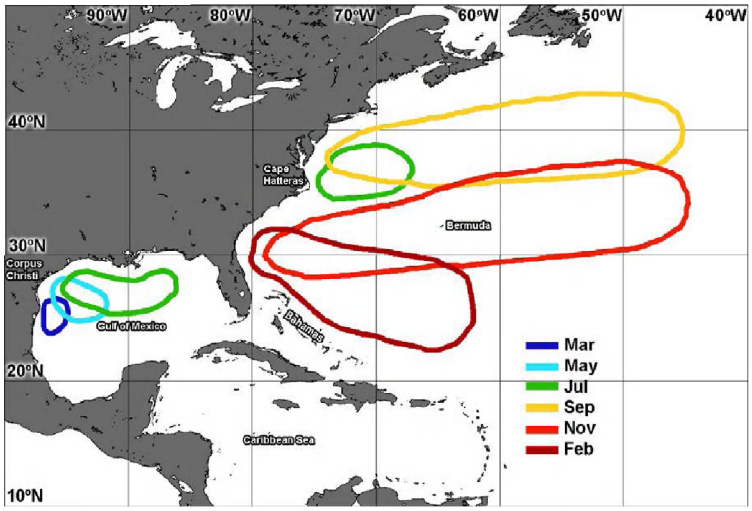

Figure 4. Simplified outline diagram showing the average extent of *Sargassum* in March, May, July, September, November and February, based on The Medium Resolution Imaging Specëmeter on the European Space Agency's Envisat satellite count distributions by month averaged over the years 2002 to 2007. *Sargassum* is found in the GOM throughout the year; the Figure is designed to indicate max coverage time. (Gower and King, 2008).

Storm induced vertical mixing and beaching may also represent a significant source of mortality for the floating *Sargassum*. Loss of *Sargassum* via sinking results from physical forcing (Langmuir circulation, Johnson and Richardson 1977) and the interaction between biology and physical forcing (damaged or senesced tissue may be more susceptible to loss of vertical position). Buoyancy for pelagic *Sargassum* is enhanced by the complex morphology of the alga in which the thallus "branches" into stipe bearing leaf-like appendages (fronds) and gas-bladders resembling berries (pneumatocysts). Air in the bladders appears to accumulate through diffusion of ambient dissolved oxygen (Hurka 1971). If *Sargassum* is forced below depths of 50 m, increases in ambient pressure make it difficult for the alga to return to the neustonic environment (Johnson and Richardson 1977, Woodcock 1993). Deposition of floating Sargassum on the shoreline represents another significant loss of this habitat to the pelagic ecosystem but likely an important nutrient subsidy to sand beach ecosystems (Williams and Feagin 2010).

Floating *Sargassum* communities represent a challenging ecosystem to study, because of the logistic difficulty of high seas sampling as well as the dynamic nature of *Sargassum* communities. *Sargassum* distributions fall into three broad categories: wind rows (convergence lines), mats of various size and scattered clumps. The various morphologies are ephemeral as a result of the interactions between metrological and oceanographic conditions. The continuous cycle of break-up and new formation provides another avenue for dispersal and mixing. The frequency of these cycles likely changes in different regions along the path of *Sargassum* with the origin and terminus of the hypothesized path being more conducive to the persistence and hence larger mat or windrow formation. In contrast, the high current velocities and greater storm frequency associated with the regions of the Gulf Loop and Gulf Stream may not favor formation of large mats.

Ecosystem Services provided by Sargassum

Like other biogenic habitats, floating *Sargassum* provides several ecosystem services to coastal and open ocean ecosystem. Similar to seagrass, it a source of primary production, provides structural refuge and foraging areas for sea turtles, marine birds, fish, and invertebrates, provides a substrate for encrusting and fouling invertebrates and ephiphytic algae and bacteria, fills a critical role in nutrient cycling and provides a source of detrital material for adjacent ecosystems. Unlike near shore ecosystems, where several biogenic habitats may appear within a landscape, *Sargassum* represents the only natural three dimensional habitat on the ocean surface. Thus, the biological community supported by the pelagic brown algae complex of *S. natans* and *S. fluitans* represent floating hot-spots of diversity and productivity in an otherwise featureless landscape.

Primary Production

Net primary production varies among species of *Sargassum*. Pelagic *Sargassum* contributes a small fraction to the total primary production in the N. Atlantic; however, in the Sargasso Sea it may contribute as much as 60% of total primary production in the upper meter of the water column (Howard and Menzies 1969; Carpenter and Cox 1974; Hanson 1977; Peres

1982). Estimates of standing stock biomass of *Sargassum* have been derived based on net tows as well as satellite imagery and range from 1 g per m^{-2} to 25 g per m^{-2} (Table 1). Gower et al. (2006) estimated that floating *Sargassum* accounts for 10% of primary production in the open waters of the GOM and North Atlantic. LaPointe (1986; 1995) estimated gross production of *S. natans* at 2.38 ± 0.52 mg C (g dry weight $^{-1}$) h^{-1} in shelf waters and 1.17 ± 0.65 mg C (g dry weight $^{-1}$) h^{-1} in lower nutrient oceanic waters. Gross production estimates of S. *fluitans* were reported to be similar to *S. natans* in LaPointe 1986. Carpenter and Cox (1974) reported rates approximately 30% less in their study; however, LaPointe (1995) noted these differences were due to methodological differences between the studies and concluded the higher values were likely more realistic. Hanson (1977) reported gross production estimates ranging from 0.2 to 1.2 mg C g^{-1} h^{-1}. LaPointe (1986) estimated a doubling rate of 0.03 to 0.04 per day under ambient nutrient conditions for *S. natans* and *S. fluitans*, but noted significantly enhanced production (doubling rates of 0.5 to 0.8 per day) under higher nitrogen and phosphors availability In addition to primary production of *Sargassum*, some epiphytic species also photosynthesize and a production estimate by Carpenter and Cox 1974 of the dominant epiphyte (the cyanobacteria *Dichothrix fucicol*) was 3.8 mg C g^{-1} hr^{-1} in autumn. In addition, cyanobacteria growing on or near *Sargassum* may be a significant source of new nitrogen (Philips and Zeman 1990). This is a particularly important ecosystem service in the oligotrophic open ocean where *Sargassum* occurs. Hanson (1977), who provides estimates of N fixation at multiple stations along the Gulf Stream, estimated that the *Sargassum* community obtained a substantial part (40 %) of its nitrogen from nitrogen fixation.

Table 1. Standing stock biomass or productivity estimates of floating *Sargassum*.

Sargassum species	**Biomass/Production Rates**	**Location**	**Citation**
Sargassum sp. mats	Fractional cover for GOM is 0.0008 which equals a mass of 25 g m^{-2}	Western GOM	Gower et al. 2006
Sargassum sp.	Average biomass of 1 g m^{2} wet weight	Sargasso Sea	Parr 1939
Sargassum sp.	0.8 to 2 g m^{-2}		SAFMC 2002
Sargassum sp.	Average total mass of *Sargassum*, is about 1 million tons/year for both bodies of water for a total of 2 million tons	GOM and the Atlantic	Gower and King 2008
Sargassum sp.	A survey of pelagic *Sargassum* spp. between 1977 and 1981 showed that the biomass of the plants in the Sargasso Sea was <6% of the values in 1933 to 1935.	North Atlantic Ocean, Caribbean Sea and GOM	Stoner 1983

Habitat

Floating *Sargassum* represents an important habitat for a variety of invertebrate and vertebrate species. The alga provides substrate for attachment encrusting invertebrates (e.g., bryozoans, barnacles, hydroids, etc.). In addition to the encrusting community the plant supports, the pelagic brown algae complex of *S. natans* and *S. fluitans* supports large and diverse assemblages of invertebrates (Table 2) and marine fishes (Table 3). Fish larvae and juveniles presumably utilize these pelagic habitats as protection from predators, but *Sargassum* may also provide enhanced feeding opportunities and serve to concentrate larvae and juveniles with flotsam-seeking behaviors (Rooker et al. 2006). *Sargassum* communities, therefore, serve as

pelagic "nursery habitats" for many important fishery species, including common dolphinfish, triggerfishes, tripletail, billfishes, tunas and amberjacks, as well as ecologically important forage fish species, such as butterfishes and flyingfishes. For these reasons, *Sargassum* has been designated an Essential Fish Habitat by both the South Atlantic and GOM Fishery Management Councils and by National Marine Fisheries Service (SAFMC 2002).

Sargassum also represents a habitat for higher vertebrates (sea turtles and birds). The spill region is known to contain important numbers of juvenile, pelagic-stage sea turtles of four species, loggerhead sea turtles, green turtles, Kemp's ridleys, and hawksbill turtles (Witherington and Hirama 2006 & 2010, FWC 2008). Most of these turtles are 25 cm in carapace length or smaller and are not visible from aircraft. These turtles have a close association with pelagic *Sargassum* mats and spend the vast majority of their time at the surface (FWC 2008). During the summer hatching season on Gulf and Atlantic beaches (July through November), *Sargassum* mats in shelf waters also contain post-hatchling loggerheads in relatively high abundance (Witherington 2002), and post-hatchling green turtles in significant numbers (FWC 2008). Marine birds (Table 4) also utilize the *Sargassum* as feeding habitat in the open ocean.

Similar to other brown algae, low palatability of Sargassum to grazers as a result of the high levels of polyphenols (Pereira & Yoneshigue-Valentin 1999) may limit the transfer of *Sargassum* derived organic matter to consumers. Although Rooker et al. 2006, found the origin of the majority of organic matter in the Sargassum community was derived from ambient particulate organic matter (POM), they did find evidence of Sargassum derived organic matter entering and propagating through the foodweb. Based on stable isotopes, Rooker et al. (2006) found that *Sargassum* derived organic matter contributed on average 20-35% of the C to fishes and invertebrates. In general, higher amounts of *Sargassum* derived organic matter were seen in invertebrates; however, juveniles of three fish species (triggerfish, *Balistes capriscus*, Bluefin tuna, *Thunnus atlanticus*, and albacore *T. albacares*) showed contributions near 50%. Interestingly, the overall contribution of organic matter from *Sargassum* to the foodweb it supports was considerably less than the contribution of seagrass or kelp to their respective foodwebs (Kaehler et al. 2000, Kharlamenko et al. 2001, Rooker et al. 2006). Rapid removal of

the detrital organic matter pool via sinking may explain some of these differences; however, regional changes in the grazer pool should also be explored.

Table 2. Invertebrate species recorded in pelagic Sargassum. Density or biomass are reported when available. Total counts by species are also reported in some studies; however, in many cases a sampling volume was not recorded (note we are attempting to turn these into densities with further work).

Family	Species	Common Name	Abundance	Location	Citation
	Planes minuta		4	S. of Bermuda	Burns and Teal 1973
Campanulariidae	*Clytia noliformis*	Hydroid		Atlantic Ocean (Bermuda)	Ryland 1974
	Membranipora tubmcduta	Bryozoans		Atlantic Ocean (Bermuda)	Ryland 1974
	Janus formosa	spirorbid		Atlantic Ocean (Bermuda)	Ryland 1974
Rivulariaceae	*Calothrix crustacea*	blue-green alga		Atlantic Ocean (Bermuda)	Ryland 1974
Hippolytidae	*Latreutes fucorum*	Slender *Sargassum* shrimp	810	Northwest Atlantic Ocean	Stoner and Greening 1984
				Southeast coast of Florida	Jobe and Brooks 2009
			12	Northwestern GOM	Turner and Rooker 2006
Litiopidae	*Litiopa melanostoma*	sargassum snail	231	Northwest Atlantic Ocean	Stoner and Greening 1984
Janiridae	*Bagatus minutes*		167	Northwest Atlantic Ocean	Stoner and Greening 1984
Grapsidae	*Planes minutus*	gulfweed crab	105	Northwest Atlantic Ocean	Stoner and Greening 1984
Ampithoidae	*Sunampithoe*		94	Northwest	Stoner and Greening 1984

Family	Species	Common Name	Abundance	Location	Citation
	pelagic			Atlantic Ocean	
	Gnescioceros sargassicola		85	Northwest Atlantic Ocean	Stoner and Greening 1984
Nereididae	*Platynereis dumerilli*		66	Northwest Atlantic Ocean	Stoner and Greening 1984
Palaemonidae	*Leander tenuicornis*	Brown grass shrimp	66	Northwest Atlantic Ocean	Stoner and Greening 1984
			16	Northwest GOM	Rooker et al. 2006
			53	N. of Bermuda	Burns and Teal 1973
			12	Northwestern GOM	Turner and Rooker 2006
				Southeast coast of Florida	Jobe and Brooks 2009
Portunidae	*Portunus sayi*	sargassum swimming crab	42	Northwest Atlantic Ocean	Stoner and Greening 1984
			6	Northwest GOM	Rooker et al. 2006
			4	N. of Bermuda	Burns and Teal 1973
			12	Northwestern GOM	Turner and Rooker 2006
	Hoploplana grubei	Worm	23	Northwest Atlantic Ocean	Stoner and Greening 1984
	Callinectes sapidus	Blue crab	3	Northwest GOM	Rooker et al. 2006
	Callinectes similis	Lesser blue crab	4	Northwest GOM	Rooker et al. 2006
Pariambidae	*Hemiaegina minuta*		21	Northwest Atlantic Ocean	Stoner and Greening 1984
Phoxichilidiidae	*Anoplodactylus*		18	Northwest	Stoner and Greening 1984

Family	Species	Common Name	Abundance	Location	Citation
	petiolatus			Atlantic Ocean	
Corambidae	*Corambella depressa*		7	Northwest Atlantic Ocean	Stoner and Greening 1984
Caprellidae	*Luconacia incerta*		5	Northwest Atlantic Ocean	Stoner and Greening 1984
	Doto pygmaea		5	Northwest Atlantic Ocean	Stoner and Greening 1984
Biancolinidae	*Biancolina brassicacephala*		3	Northwest Atlantic Ocean	Stoner and Greening 1984
Scyllaeidae	*Scyllaea pelagic*	sargassum nudibranch	3	Northwest Atlantic Ocean	Stoner and Greening 1984
			12	Northwestern GOM	Turner and Rooker 2006
Hippolytidae	*Hippolyte coerulenscens*		2	Northwest Atlantic Ocean	Stoner and Greening 1984
Alpheidae	*Latreutes ensiferus*	Snapping shrimp	6	Northwest GOM	Rooker et al. 2006
	Membraniporum sp.	(bryozoan)	6	Northwestern GOM	Turner and Rooker 2006
	Algaophenia latecarinata)	(hydroid cnidarian	6	Northwestern GOM	Turner and Rooker 2006
	Spirorbis sp.	(serpulid polychaete	6	Northwestern GOM	Turner and Rooker 2006
Order Foraminiferida	Planorbulina acervalis			North Atlantic/GOM	Coston-Clements et al. 1991
	Rosalina sp.			North Atlantic/GOM	Coston-Clements et al. 1991
Order Hydroida	Aglaeophenia latecarinata			North Atlantic/GOM	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance	Location	Citation
	A. minuta			North Atlantic/GOM	Coston-Clements et al. 1991
	A. perpusilla			North Atlantic/GOM	Coston-Clements et al. 1991
	A. rigida			North Atlantic/GOM	Coston-Clements et al. 1991
	Aglaeophenoides mammillata			North Atlantic/GOM	Coston-Clements et al. 1991
	Antenella secundaria			North Atlantic/GOM	Coston-Clements et al. 1991
	Campanularia volubilis			North Atlantic/GOM	Coston-Clements et al. 1991
	Cladocryne pelagica			North Atlantic/GOM	Coston-Clements et al. 1991
	Clytia bicophora			North Atlantic/GOM	Coston-Clements et al. 1991
	C. cylindrica			North Atlantic/GOM	Coston-Clements et al. 1991
	C. johnstoni			North Atlantic/GOM	Coston-Clements et al. 1991
	C. longicyatha			North Atlantic/GOM	Coston-Clements et al. 1991
	C. noliformis			North Atlantic/GOM	Coston-Clements et al. 1991
	C. raridentata			North Atlantic/GOM	Coston-Clements et al. 1991
	C. simplex			North Atlantic/GOM	Coston-Clements et al. 1991
	Desmocyphus pumilus			North Atlantic/GOM	Coston-Clements et al. 1991
	Dynamena			North	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance	Location	Citation
	quadridentata			Atlantic/GOM	
	Eucopella sargassicola			North Atlantic/GOM	Coston-Clements et al. 1991
	Gemmaria sp.			North Atlantic/GOM	Coston-Clements et al. 1991
	Gonothyraca gracilis			North Atlantic/GOM	Coston-Clements et al. 1991
	G. integra			North Atlantic/GOM	Coston-Clements et al. 1991
	Halecium nanum			North Atlantic/GOM	Coston-Clements et al. 1991
	Hebella calcarata			North Atlantic/GOM	Coston-Clements et al. 1991
	Laomedea sp.			North Atlantic/GOM	Coston-Clements et al. 1991
	Obelia bicuspidata			North Atlantic/GOM	Coston-Clements et al. 1991
	O. dichotoma			North Atlantic/GOM	Coston-Clements et al. 1991
	O. geniculata			North Atlantic/GOM	Coston-Clements et al. 1991
	O. hyalina			North Atlantic/GOM	Coston-Clements et al. 1991
	Plumularia catharina			North Atlantic/GOM	Coston-Clements et al. 1991
	P. corrugata			North Atlantic/GOM	Coston-Clements et al. 1991
	P. diaphana			North Atlantic/GOM	Coston-Clements et al. 1991
	P. floridana			North Atlantic/GOM	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance	Location	Citation
	P. margaretta			North Atlantic/GOM	Coston-Clements et al. 1991
	P. megalocephala			North Atlantic/GOM	Coston-Clements et al. 1991
	P. obligua			North Atlantic/GOM	Coston-Clements et al. 1991
	P. sargassi			North Atlantic/GOM	Coston-Clements et al. 1991
	P. setaceoides			North Atlantic/GOM	Coston-Clements et al. 1991
	P. strictocarpa			North Atlantic/GOM	Coston-Clements et al. 1991
	Scandia mutabilis			North Atlantic/GOM	Coston-Clements et al. 1991
	Setularia amplectens			North Atlantic/GOM	Coston-Clements et al. 1991
	S. brevicyathus			North Atlantic/GOM	Coston-Clements et al. 1991
	S. corcicina			North Atlantic/GOM	Coston-Clements et al. 1991
	S. exigua			North Atlantic/GOM	Coston-Clements et al. 1991
	S.flowersi			North Atlantic/GOM	Coston-Clements et al. 1991
	S. gracilis			North Atlantic/GOM	Coston-Clements et al. 1991
	S. inflata			North Atlantic/GOM	Coston-Clements et al. 1991
	S. mayeri			North Atlantic/GOM	Coston-Clements et al. 1991
	S. rathbuni			North	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance	Location	Citation
				Atlantic/GOM	
	P. stookeyi			North Atlantic/GOM	Coston-Clements et al. 1991
	S. turbinata			North Atlantic/GOM	Coston-Clements et al. 1991
	S. versluysi			North Atlantic/GOM	Coston-Clements et al. 1991
	Syncoryne mirabilis			North Atlantic/GOM	Coston-Clements et al. 1991
	Zanclea costata			North Atlantic/GOM	Coston-Clements et al. 1991
	Z. gemmosa			North Atlantic/GOM	Coston-Clements et al. 1991
Order Actiniaria	Anemonia sargassensis			North Atlantic/GOM	Coston-Clements et al. 1991
Order Acoela	Amphiscolopus sargussi			North Atlantic/GOM	Coston-Clements et al. 1991
Order Polycladida	Acerotisa notulata			North Atlantic/GOM	Coston-Clements et al. 1991
	Holoplana grubei			North Atlantic/GOM	Coston-Clements et al. 1991
	Stylochus mertensi			North Atlantic/GOM	Coston-Clements et al. 1991
	S. pellucidus			North Atlantic/GOM	Coston-Clements et al. 1991
	Gnescioceros sargassicola			North Atlantic/GOM	Coston-Clements et al. 1991
Order Phyllodocida	Alciope contrainii			North Atlantic/GOM	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance	Location	Citation
	Harmothoe dearborni			North Atlantic/GOM	Coston-Clements et al. 1991
	Platyneris coccinea			North Atlantic/GOM	Coston-Clements et al. 1991
	P. dumerillii			North Atlantic/GOM	Coston-Clements et al. 1991
Order Sabellida	Spirorbis corrugatus			North Atlantic/GOM	Coston-Clements et al. 1991
Order Amphinomida	Amphinome rostrata			North Atlantic/GOM	Coston-Clements et al. 1991
Class Pycnogonida	Anoplodactylus petiolatus			North Atlantic/GOM	Coston-Clements et al. 1991
	Endeis spinosa			North Atlantic/GOM	Coston-Clements et al. 1991
	Tanystylum orbiculaire			North Atlantic/GOM	Coston-Clements et al. 1991
Order Cladocera	Evadne spinifera			North Atlantic/GOM	Coston-Clements et al. 1991
Order Harpacticoida	Amonardia phyllopus			North Atlantic/GOM	Coston-Clements et al. 1991
	Dactylopodia tisboides			North Atlantic/GOM	Coston-Clements et al. 1991
	Harpacticus gurney			North Atlantic/GOM	Coston-Clements et al. 1991
	Paradactylopodia oculata			North Atlantic/GOM	Coston-Clements et al. 1991
	Paralaophonte congenera			North Atlantic/GOM	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance	Location	Citation
	Scutellidium longicauda			North Atlantic/GOM	Coston-Clements et al. 1991
Order Cyclopoida	Macrochiron avirostrum			North Atlantic/GOM	Coston-Clements et al. 1991
	M. hudsoni			North Atlantic/GOM	Coston-Clements et al. 1991
	M. sargassi			North Atlantic/GOM	Coston-Clements et al. 1991
	Copilia mediterranea			North Atlantic/GOM	Coston-Clements et al. 1991
Order Thoracica	Conchoderma virgatum			North Atlantic/GOM	Coston-Clements et al. 1991
	Lepas anatifera			North Atlantic/GOM	Coston-Clements et al. 1991
	L. anserifera			North Atlantic/GOM	Coston-Clements et al. 1991
	L. australis			North Atlantic/GOM	Coston-Clements et al. 1991
	L. fascicularis			North Atlantic/GOM	Coston-Clements et al. 1991
	L. hilli			North Atlantic/GOM	Coston-Clements et al. 1991
	L. pectinata			North Atlantic/GOM	Coston-Clements et al. 1991
Order Decapoda	Alpheus sp .			North Atlantic/GOM	Coston-Clements et al. 1991
	Carataspis monstrosa			North Atlantic/GOM	Coston-Clements et al. 1991
	C. petiti			North	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance	Location	Citation
				Atlantic/GOM	
	Hippolyte coerulescens			North Atlantic/GOM	Coston-Clements et al. 1991
	H. ensiferus			North Atlantic/GOM	Coston-Clements et al. 1991
	H. tenuirostris			North Atlantic/GOM	Coston-Clements et al. 1991
	H. zoztericola			North Atlantic/GOM	Coston-Clements et al. 1991
	Latreutes ensiferus			North Atlantic/GOM	Coston-Clements et al. 1991
	L. fucorum			North Atlantic/GOM	Coston-Clements et al. 1991
	Leander tenuicornis			North Atlantic/GOM	Coston-Clements et al. 1991
	Palaemon natator			North Atlantic/GOM	Coston-Clements et al. 1991
	P. pelagicus			North Atlantic/GOM	Coston-Clements et al. 1991
	Planes minutus			North Atlantic/GOM	Coston-Clements et al. 1991
	Portunus sayi			North Atlantic/GOM	Coston-Clements et al. 1991
	P. spinimanus			North Atlantic/GOM	Coston-Clements et al. 1991
	Sergestes oculatus			North Atlantic/GOM	Coston-Clements et al. 1991
	Tozeuma carolinense			North Atlantic/GOM	Coston-Clements et al. 1991
	Virbius acuminatus			North Atlantic/GOM	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance	Location	Citation
Order Isopoda	Anatanais normani			North Atlantic/GOM	Coston-Clements et al. 1991
	Bagatus minutus			North Atlantic/GOM	Coston-Clements et al. 1991
	Bopyroides latreuticola			North Atlantic/GOM	Coston-Clements et al. 1991
	Bopyrus squillarum			North Atlantic/GOM	Coston-Clements et al. 1991
	Idotea baltica			North Atlantic/GOM	Coston-Clements et al. 1991
	I. metallica			North Atlantic/GOM	Coston-Clements et al. 1991
	I. whymperi			North Atlantic/GOM	Coston-Clements et al. 1991
	Janira minuta			North Atlantic/GOM	Coston-Clements et al. 1991
	Paradynamene benjamensis			North Atlantic/GOM	Coston-Clements et al. 1991
	Probopyrus latreuticola			North Atlantic/GOM	Coston-Clements et al. 1991
Order Amphipoda	Ampithoe longimana			North Atlantic/GOM	Coston-Clements et al. 1991
	A. pelagica			North Atlantic/GOM	Coston-Clements et al. 1991
	Biancolina brassicaecephala			North Atlantic/GOM	Coston-Clements et al. 1991
	Caprella danilevskii			North Atlantic/GOM	Coston-Clements et al. 1991
	Hemiaegina minuta			North Atlantic/GOM	Coston-Clements et al. 1991
	Luconacia incerta			North	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance	Location	Citation
				Atlantic/GOM	
	Sunampithoe pelagica			North Atlantic/GOM	Coston-Clements et al. 1991
	Vibilia pelagica			North Atlantic/GOM	Coston-Clements et al. 1991
				North Atlantic/GOM	Coston-Clements et al. 1991
Order Heterotardigrada	Styraconyx sargassi			North Atlantic/GOM	Coston-Clements et al. 1991
Order Mesogastropoda	Bittium sp.			North Atlantic/GOM	Coston-Clements et al. 1991
	Litiopa melanostoma			North Atlantic/GOM	Coston-Clements et al. 1991
	Rissoa sp.			North Atlantic/GOM	Coston-Clements et al. 1991
Order Thecosomata	Creseis spinifera			North Atlantic/GOM	Coston-Clements et al. 1991
Order Nudibranchia	Aeolidiella occidentalis			North Atlantic/GOM	Coston-Clements et al. 1991
	Corambella depressa			North Atlantic/GOM	Coston-Clements et al. 1991
	Cuthona pumilio			North Atlantic/GOM	Coston-Clements et al. 1991
	Doridella obscura			North Atlantic/GOM	Coston-Clements et al. 1991
	Doto pygmaea			North Atlantic/GOM	Coston-Clements et al. 1991
	Fiana pinnata			North Atlantic/GOM	Coston-Clements et al. 1991
	Glaucus atlanticus			North Atlantic/GOM	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance	Location	Citation
	Scyllaea pelagica			North Atlantic/GOM	Coston-Clements et al. 1991
	Spurilla sargassicola			North Atlantic/GOM	Coston-Clements et al. 1991
	S. neapolitana			North Atlantic/GOM	Coston-Clements et al. 1991
	Tethys protea			North Atlantic/GOM	Coston-Clements et al. 1991
Order Teuthoida	Onychia carihaea			North Atlantic/GOM	Coston-Clements et al. 1991
Order Cheilostomata	Aetea anguina			North Atlantic/GOM	Coston-Clements et al. 1991
	Membranipora turberculata			North Atlantic/GOM	Coston-Clements et al. 1991
	Thalamoperella falcifera			North Atlantic/GOM	Coston-Clements et al. 1991

Table 3. Fish species recorded in pelagic Sargassum. Abundnace or biomass are reported when available. Total counts by species are also reported in some studies; however, in many cases a sampling volume was not recorded (note we are attempting to turn these into densities with further work). * = early life stage present (i.e. egg, larvae or juvenile), MRA=mean relative abundance, CC=free floating video cameras, ROV=remote operated vehicle, DN=dip net, NU=neuston net.

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
Acanthuridae	*Acanthurus randalli*	gulf surgeonfish		North Atlantic/GOM	Coston-Clements et al. 1991
Ammodytidae	*Ammodytes tobianus/Hyperoplus lanceolatus*	Small sand eel	884	North Sea	Vandendriessche et al. 2007
Antennariidae	*Histrio histrio (Pterophryne histrio)*	* *Sargassum* fish		North Atlantic/GOM	Coston-Clements et al. 1991, Gudger 1937
			368	Northwest GOM	Wells and Rooker 2003, 2004 a
			18 (8.76 g)	N. of Bermuda	Burns and Teal 1973
		*	75	Sargasso Sea	Smith Jr. 1973
			9	Northwest Atlantic Ocean	Stoner and Greening 1984
			19	Northwestern GOM	Turner and Rooker 2006
			113	Northcentral GOM	Hoffmayer et al. 2005
			15	Northwest GOM	Rooker et al. 2006
Antherinidae		*silversides	19	Northcentral GOM	Hoffmayer et al. 2005
Anthiinae	*Hemanthias vivanus*	*red barbier	3	Northcentral GOM	Hoffmayer et al. 2005
Apogonidae	*Apogon maculatus*	* flamefish		North Atlantic/GOM	Coston-Clements et al. 1991
	Apogonidae sp.	*cardinalfish	1	Northcentral	Hoffmayer et al. 2005

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
				GOM	
Balistidae	*Balistes capriscus*	* gray triggerfish		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991, Rooker et al. 2004
			10.31-CC; 1.58-ROV; 13.17-DN (% MRA)	Gulf	Moser et al. 1998
			27	Northwestern GOM	Turner and Rooker 2006
			1604	Northwestern GOM	Wells and Rooker 2003, 2004 a
			208	Northcentral GOM	Hoffmayer et al. 2005
			39	Northwest GOM	Rooker et al. 2006
	Canthidermis maculata	* rough triggerfish		North Atlantic/GOM	Coston-Clements et al. 1991
			3	Northwestern GOM	Wells and Rooker 2003, 2004 a
			28	Northcentral GOM	Hoffmayer et al. 2005
	Canthidermis sufflamen	* ocean triggerfish		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991
			14.2-CC; 3.59-ROV; 2.83-DN (% MRA)	Gulf	Moser et al. 1998
			4	Northcentral GOM	Hoffmayer et al. 2005
	Canthidermis sp.	triggerfish	1 (7.42 g)	N. of Bermuda	Burns and Teal 1973

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
	Xanthichthys ringens	* sargassum triggerfish		North Atlantic/GOM	Coston-Clements et al. 1991
	Balistidae sp.	*	22.52-CC; 4.82-ROV(% MRA)	Gulf	Moser et al. 1998
Belonidae	*Tylosurus acus*	*agujon		North Atlantic/GOM	Coston-Clements et al. 1991
	Belone Belone	garfish	69 (NU); 1 (DN)	North Sea	Vandendriessche et al. 2007
	Platybelone argalus	* keeled needlefish	1	Northcentral GOM	Hoffmayer et al. 2005
Blennidae	*unidentified*	* blenny		North Atlantic/GOM	Coston-Clements et al. 1991
	Hypsoblennies sp.	*blenny	10	Northcentral GOM	Hoffmayer et al. 2005
	Blennidae sp.	Blenny	2 (DN)	North Sea	Vandendriessche et al. 2007
Bothidae	*Cyclopsetta chittendeni*	*Mexican flounder	3	Northcentral GOM	Hoffmayer et al. 2005
	Trichopsetta ventralis	*sash flounder	4	Northcentral GOM	Hoffmayer et al. 2005
	Citharichthys macrops	*spotted whiff	2	Northcentral GOM	Hoffmayer et al. 2005
	Citharichthys spilopterus	*bay whiff	3	Northcentral GOM	Hoffmayer et al. 2005
	Bothus sp.	*flounder	17	Northcentral GOM	Hoffmayer et al. 2005
	Citharichthys sp.		2	Northcentral GOM	Hoffmayer et al. 2005
	Cyclopsetta sp.		3	Northcentral GOM	Hoffmayer et al. 2005
	Etropus sp.	*flounder	1	Northcentral GOM	Hoffmayer et al. 2005
	Syacium sp.		9	Northcentral	Hoffmayer et al. 2005

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
				GOM	
	Arnoglossus laterna	Mediterranean scaldfish	1 (NU)	North Sea	Vandendriessche et al. 2007
Bregmacerotidae	*Bregmaceros cantori*	*codlet	25	Northcentral GOM	Hoffmayer et al. 2005
	Bregmacerous sp.	*	6	Northcentral GOM	Hoffmayer et al. 2005
Callionymidae	*Callionymus lyra*	Dragonet	1 (DN)	North Sea	Vandendriessche et al. 2007
Carcharhinidae	*Carcharhinus falciformes*	silky shark		North Atlantic/GOM	Coston-Clements et al. 1991
	Carcharhinus limbatus	blacktip shark		North Atlantic/GOM	Coston-Clements et al. 1991
	Carcharhinus longimanus	Oceanic whitetip shark		North Atlantic/GOM	Coston-Clements et al. 1991
Carangidae	*Caranx bartholomaei*	* Yellow jack		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991
			8.0-DN (% MRA)	Stream off Cape Hatteras, North Carolina	Moser et al. 1998
			11	Northwestern GOM	Wells and Rooker 2003, 2004 a
			4	Northwest GOM	Rooker et al. 2006
	Caranx crysos	* blue runner		North Atlantic/GOM	Coston-Clements et al. 1991, Rooker et al. 2004
			18	Northwestern GOM	Turner and Rooker 2006
			1827	Northwestern GOM	Wells and Rooker 2003, 2004 a

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
			773	Northcentral GOM	Hoffmayer et al. 2005
			23	Northwest GOM	Rooker et al. 2006
	Caranx dentex	* white trevally		North Atlantic/GOM	Coston-Clements et al. 1991
	Caranx hippos	* crevalle jack		North Atlantic/GOM	Coston-Clements et al. 1991
			1	Northwestern GOM	Wells and Rooker 2003, 2004 a
			15	Northcentral GOM	Hoffmayer et al. 2005
	Caranx latus	* horse-eye jack		North Atlantic/GOM	Coston-Clements et al. 1991
			1	Northcentral GOM	Hoffmayer et al. 2005
	Caranx ruber	* bar jack		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991
			10.99-CC; 9.93-ROV (% MRA)	Gulf	Moser et al. 1998
			40	Northcentral GOM	Hoffmayer et al. 2005
	Caranx spp.	*jack	34	Northcentral GOM	Hoffmayer et al. 2005
			84.79-CC; 72.19-ROV(% MRA)	Stream off Cape Hatteras, North Carolina	Moser et al. 1998
	Chloroscombrus chrysurus	* Atlantic bumper		North Atlantic/GOM	Coston-Clements et al. 1991
			71	Northcentral	Hoffmayer et al. 2005

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
				GOM	
	Decapterus macerellus	* mackarel scad		North Atlantic/GOM	Coston-Clements et al. 1991
	Decapterus punctatus	* round scad		North Atlantic/GOM	Coston-Clements et al. 1991
			24	Northwestern GOM	Wells and Rooker 2003, 2004 a
			9	Northcentral GOM	Hoffmayer et al. 2005
	Decapterus tabl	* redtail scad		North Atlantic/GOM	Coston-Clements et al. 1991
	Decapterus spp.		30.22-ROV(% MRA)	Gulf	Moser et al. 1998
	Elagatis bipinnulata	* rainbow runner		North Atlantic/GOM/Gu lf Stream	Coston-Clements et al. 1991
			2.54-CC; 10.15-ROV(% MRA)	Stream off Cape Hatteras, North Carolina	Moser et al. 1998
			84	Northcentral GOM	Hoffmayer et al. 2005
			5	Northwestern GOM	Wells and Rooker 2003, 2004 a
	Naucrates ductor	pilotfish		North Atlantic/GOM/ Cape Hatteras	Coston-Clements et al. 1991, Moser et al. 1998
	Seler crumenophthalmus	* bigeye scad		North Atlantic/GOM	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
			63	Northcentral GOM	Hoffmayer et al. 2005
	Seriola dumerili	* greater amberjack		North Atlantic/GOM	Coston-Clements et al. 1991, Rooker et al. 2004, Wells and Rooker 2004 b,
			20	Northwestern GOM	Turner and Rooker 2006
			154	Northwestern GOM	Wells and Rooker 2003, 2004 a
			29	Northcentral GOM	Hoffmayer et al. 2005
			15	Northwest GOM	Rooker et al. 2006
	Seriola fasciata	* lesser amberjack		North Atlantic/GOM	Coston-Clements et al. 1991
			5	Northwestern GOM	Wells and Rooker 2003, 2004 a
			29	Northcentral GOM	Hoffmayer et al. 2005
	Seriola rivoliana	* almaco jack		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991
			3.56-ROV; 3.33-DN(% MRA)	Gulf	Moser et al. 1998
			17	Northwestern GOM	Wells and Rooker 2003, 2004 a
			45	Northcentral GOM	Hoffmayer et al. 2005
			4	Northwest GOM	Rooker et al. 2006
	Seriola zonata	* banded rudderfish		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991
			2.36-CC; 10.31-	Stream off Cape	Moser et al. 1998

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
			ROV(% MRA)	Hatteras, North Carolina	
			2	Northcentral GOM	Hoffmayer et al. 2005
	Seriola sp.	*	110	Northcentral GOM	Hoffmayer et al. 2005
			10.58-CC; 2.88-ROV; 3.33-DN(% MRA)	Gulf	Moser et al. 1998
	Tachurus lathami	* rough scad		North Atlantic/GOM	Coston-Clements et al. 1991
			81	Northcentral GOM	Hoffmayer et al. 2005
	Trachinotus carolinus	*Florida pompano	16	Northcentral GOM	Hoffmayer et al. 2005
	Trachurus trachurus	Atlantic horse mackerel	258 (NU); 147 (DN)	North Sea	Vandendriessche et al. 2007
	Oligoplites saurus	*leatherjacket	117	Northcentral GOM	Hoffmayer et al. 2005
	Selene sp.	*	5	Northcentral GOM	Hoffmayer et al. 2005
	Carangidae sp.	*	9 (Larvae per $100m^{3)}$	North Central GOM	Comyns et al. 2002
Centriscidae	*Macroramphosus scolopax*	longspine snipefish		North Atlantic/GOM	Coston-Clements et al. 1991
Chaetodontidae	*Chaetodon ocellatus*	*spotfin butterflyfish		North Atlantic/GOM	Coston-Clements et al. 1991
	Chaetodon striatus	* banded butterflyfish		North Atlantic/GOM	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
	Chaetodontidae sp.	*butterfly fish	1	Northcentral GOM	Hoffmayer et al. 2005
Clupeidae	*Etrumeus teres*	*red-eye round herring	191	Northcentral GOM	Hoffmayer et al. 2005
	Harengula jaguana	Scaled sardine	6	Northcentral GOM	Hoffmayer et al. 2005
			23	Northwestern GOM	Wells and Rooker 2003, 2004 a
	Opisthonema oglinum	*atlantic thread herring	12	Northcentral GOM	Hoffmayer et al. 2005
	Sardinella aurita		1	Northwestern GOM	Wells and Rooker 2003, 2004 a
			48	Northcentral GOM	Hoffmayer et al. 2005
	Clupea harengus/Sprattus sprattus/ Engraulis encrassicolus	Atlantic herring	2257 (NU)	North Sea	Vandendriessche et al. 2007
Coryphaenidae	*Coryphaena hippurus*	* dolphin		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991, Rooker et al. 2004
			11.52-CC; 9.95-ROV(% MRA)	Stream off Cape Hatteras, North Carolina	Moser et al. 1998
			9	Northwestern GOM	Turner and Rooker 2006
			1	Northwestern GOM	Wells and Rooker 2003, 2004 a
			9	Northwest GOM	Rooker et al. 2006

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
			25	Northern GOM	Wells and Rooker 2009
	Coryphaena equiselis	*pompano dolphin		GOM	Hoffmayer et al. 2005
			24	Northern GOM	Wells and Rooker 2009
Cottidae	*Cottidae sp.*	sculpin	290 (NU);13 (DN)	North Sea	Vandendriessche et al. 2007
Cyclopteridae	*Cyclopterus lumpus*	lumpfish	97 (DN)	North Sea	Vandendriessche et al. 2007
Cynoglossidae	*Symphurus plagiusa*	*blackcheek tonguefish	3	Northcentral GOM	Hoffmayer et al. 2005
	Symphurus sp.		31	Northcentral GOM	Hoffmayer et al. 2005
Dactylopteridae	*Dactylopterus volitans*	*flying gurnard	1	Northcentral GOM	Hoffmayer et al. 2005
Diodontidae	*Diodon holocanthus*	Long spine porcupine fish	1	Northcentral GOM	Hoffmayer et al. 2005
			1	Northwestern GOM	Wells and Rooker 2003, 2004 a
	Diodon hystix	*spot-fin porcupinefish	3	Northcentral GOM	Hoffmayer et al. 2005
	Chilomycterus schoepfi	*striped burfish	1	Northcentral GOM	Hoffmayer et al. 2005
Echeneidae	*Phtheirichthys lineatus*	slender suckerfish		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991, Moser et al. 1998
			8.33-DN (% MRA)	Gulf	Moser et al. 1998
	Remora sp.	*remora	3	Northcentral GOM	Hoffmayer et al. 2005
Engraulidae	*Anchoa hepsetus*	Broad-striped anchovy	2	Northcentral GOM	Hoffmayer et al. 2005
			24	Northwestern	Wells and Rooker 2003, 2004 a

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
				GOM	
Exocoetidae	*Cypselurus furcatus*	spotfin flyingfish		North Atlantic/GOM	Coston-Clements et al. 1991
	Cheilopogon cyanopterus	*	1	Northcentral GOM	Hoffmayer et al. 2005
	Cheilopogon melanurus	*Atlantic flyingfish		North Atlantic/GOM	Coston-Clements et al. 1991
			21	Northcentral GOM	Hoffmayer et al. 2005
	Cheilopogon sp.	*	6	Northcentral GOM	Hoffmayer et al. 2005
	Cheilopogon exsiliens	*bandwing flyingfish	241	Northcentral GOM	Hoffmayer et al. 2005
	Cheilopogon furcatus	*spotfin flyingfish	101	Northcentral GOM	Hoffmayer et al. 2005
	Exocoetus obtusirostris	*oceanic-two-wing flyingfish		North Atlantic/GOM	Coston-Clements et al. 1991
			31	Northcentral GOM	Hoffmayer et al. 2005
	Hemiramphus balao	balao		North Atlantic/GOM	Coston-Clements et al. 1991
	Exonautes rondeleti	Flying fish			Gudger 1937
	Hemiramphus brasiliensis	ballyhoo		North Atlantic/GOM	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
	Hirundichthys affinis	*fourwing flyingfish		North Atlantic/GOM	Coston-Clements et al. 1991
			147	Northcentral GOM	Hoffmayer et al. 2005
	Hyporhamphus unifasciatus	silverstripe halfbeak		North Atlantic/GOM	Coston-Clements et al. 1991
	Parexocoetus brachypterus	*sailfin flyingfish		North Atlantic/GOM	Coston-Clements et al. 1991
			67	Northcentral GOM	Hoffmayer et al. 2005
	Prognichthys occidentalis	*	2765	Northcentral GOM	Hoffmayer et al. 2005
	Oxyporamphus micropterus	*	496	Northcentral GOM	Hoffmayer et al. 2005
	Exocoetidae sp.	*	7 (Larvae per $100m^{3)}$	North Central GOM	Comyns et al. 2002
Fistulariidae	*Fistularia tabacaria*	* bluespotted cornetfish		North Atlantic/GOM	Coston-Clements et al. 1991
Gadidae	*Urophycis earlli*	* Carolina hake		North Atlantic/GOM	Coston-Clements et al. 1991
	Urophycis floridana	*southern hake		North Atlantic/GOM	Coston-Clements et al. 1991
	Merlangius merlangus	whiting	10 (NU);1 (DN)	North Sea	Vandendriessche et al. 2007
	Pollachius pollachius	pollack	1 (NU); 11 (DN)	North Sea	Vandendriessche et al. 2007
	Pollachius virens	Saithe	1 (NU); 1 (DN)	North Sea	Vandendriessche et al. 2007

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
Gempylidae	*Gempylus serpens*	*	18	Northcentral GOM	Hoffmayer et al. 2005
Gerreidae		*mojarra	8	Northcentral GOM	Hoffmayer et al. 2005
Gobiidae	*Gobiidae sp.*	Gobies	2 (DN)	North Sea	Vandendriessche et al. 2007
Gonostomatidae	*Cyclothone sp.*	*	25	Northcentral GOM	Hoffmayer et al. 2005
Grammistinae		*	2	Northcentral GOM	Hoffmayer et al. 2005
Haemulidae	*Conodon nobilis*		2	Northwestern GOM	Wells and Rooker 2003, 2004 a
Hemiramphidae		*	8	Northcentral GOM	Hoffmayer et al. 2005
Holocentridae		*squirrelfish	1	Northcentral GOM	Hoffmayer et al. 2005
Istiophoridae	*Istiophorus platypterus*	* sailfish		North Atlantic/GOM	Coston-Clements et al. 1991
			50	Northern GOM	Wells and Rooker 2009
	Makaira nigricans	* blue marlin		North Atlantic/GOM	Coston-Clements et al. 1991, Rooker et al. 2004
			3	Northwest GOM	Rooker et al. 2006
			46	Northern GOM	Wells and Rooker 2009
	Tetrapturus albidus	* white marlin		North Atlantic/GOM	Coston-Clements et al. 1991
	Sebastes inermis	*rockfish	345	N. Pacific Ocean	Plaza et al. 2010
	Istiophoridae sp.	*	50	Northcentral GOM	Hoffmayer et al. 2005
	Psenes spp			Gulf	Moser et al. 1998
Kyphosidae	*Kyphosus incisor*	* yellow chub		North	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
				Atlantic/GOM/Gulf Stream	
			0.33-DN (% MRA)	Stream off Cape Hatteras, North Carolina	Moser et al. 1998
			7	Northwestern GOM	Wells and Rooker 2003, 2004 a
			148	Northcentral GOM	Hoffmayer et al. 2005
	Kyphosus sectatrix	* Bermuda chub		North Atlantic/GOM	Coston-Clements et al. 1991
			7	Northwestern GOM	Wells and Rooker 2003, 2004 a
			3	Northwest GOM	Rooker et al. 2006
	Kyphosus sp.		158	Northcentral GOM	Hoffmayer et al. 2005
Labridae	*Bodianus pulchellus*	* spotfin hogfish		North Atlantic/GOM	Coston-Clements et al. 1991
	Thalassoma bifasciatum	* bluehead		North Atlantic/GOM	Coston-Clements et al. 1991
	Labrus sp.	*	2	Northcentral GOM	Hoffmayer et al. 2005
	Labrus bergylta	Ballan wrasse	2 (NU)	North Sea	Vandendriessche et al. 2007
Lobotidae	*Lobotes surinamensis*	* tripletail		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991
			1.21-CC (% MRA)	Gulf	Moser et al. 1998
			16	Northwestern	Wells and Rooker 2003, 2004 a

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
				GOM	
			120	Northcentral GOM	Hoffmayer et al. 2005
Lotidae	*Ciliata mustela*	Fivebeard rockling	405 (NU);147 (DN)	North Sea	Vandendriessche et al. 2007
Lutjanidae	*Rhomboplites hippurus*	* vermilion snapper		North Atlantic/GOM	Coston-Clements et al. 1991
	Pristiponoides aquilonaris	*wenchman	4	Northcentral GOM	Hoffmayer et al. 2005
	Lutjanus sp.		1	Northcentral GOM	Hoffmayer et al. 2005
Melanostomatidae	*Bathophilis sp.*	*	1	Northcentral GOM	Hoffmayer et al. 2005
	Eustomas sp.	*	1	Northcentral GOM	Hoffmayer et al. 2005
Microdesmidae		*	4	Northcentral GOM	Hoffmayer et al. 2005
Molidae	*Mola sp.*	sunfish		North Atlantic/GOM	Coston-Clements et al. 1991
Monacanthidae	*Aluterus heudeloti*	* dottorel filefish		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991
			2.33-DN (% MRA)	Stream off Cape Hatteras, North Carolina	Moser et al. 1998
			21	Northwestern GOM	Wells and Rooker 2003, 2004 a
			1	Northcentral GOM	Hoffmayer et al. 2005

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
			3	Northwest GOM	Rooker et al. 2006
	Aluterus monoceros	* unicorn filefish		North Atlantic/GOM	Coston-Clements et al. 1991
			2	Northwestern GOM	Wells and Rooker 2003, 2004 a
	Aluterus schoepfi	* orange filefish		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991
			4.50-DN (% MRA)	Gulf	Moser et al. 1998
			2	Northcentral GOM	Hoffmayer et al. 2005
	Aluterus scriptus	* scrawled filefish		North Atlantic/GOM	Coston-Clements et al. 1991
			35	Northwestern GOM	Wells and Rooker 2003, 2004 a
			9	Northcentral GOM	Hoffmayer et al. 2005
			4	Northwest GOM	Rooker et al. 2006
	Aluterus spp.		22.23-CC; 23.68-ROV; 2.00-DN (% MRA)	Stream off Cape Hatteras, North Carolina	Moser et al. 1998
	Cantherhines macrocerus	* whitespotted filefish		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991
			0.07-ROV; 1.85-DN (% MRA)	Stream off Cape Hatteras, North Carolina	Moser et al. 1998
			1	Northcentral	Hoffmayer et al. 2005

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
				GOM	
	Cantherhines pullus	* orangespotted filefish		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991
			2.12-CC; 4.33-DN (% MRA)	Gulf	Moser et al. 1998
			19	Northwestern GOM	Wells and Rooker 2003, 2004 a
			4	Northcentral GOM	Hoffmayer et al. 2005
	Cantherines spp.		2.76-ROV(% MRA)	Stream off Cape Hatteras, North Carolina	Moser et al. 1998
	Monacanthus ciliatus	* fringed filefish		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991
			0.67-DN (% MRA)	Stream off Cape Hatteras, North Carolina	Moser et al. 1998
			4	Northcentral GOM	Hoffmayer et al. 2005
	Monacanthus hispidus	* planehead filefish		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991, Rooker et al. 2004
			20	Northwestern GOM	Turner and Rooker 2006
			3.34-ROV; 39.50-DN (% MRA)	Gulf	Moser et al. 1998
			22	Northwest Atlantic Ocean	Stoner and Greening 1984
			4621	Northwestern	Wells and Rooker 2003, 2004 a

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
				GOM	
			276	Northcentral GOM	Hoffmayer et al. 2005
			11	Northwest GOM	Rooker et al. 2006
	Monacanthus setifer	* slender filefish		North Atlantic/GOM	Coston-Clements et al. 1991
			16	Northwestern GOM	Wells and Rooker 2003, 2004 a
			20	Northcentral GOM	Hoffmayer et al. 2005
	Monacanthus tuckeri	* pygmy filefish		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991, Moser et al. 1998
			0.33-DN (% MRA)	Stream off Cape Hatteras, North Carolina	Moser et al. 1998
	Monacanthus spp.	*	1 (Larvae per $100m^{3)}$	North Central GOM	Comyns et al. 2002
			10.91-ROV; 8.33-DN (% MRA)	Gulf	Moser et al. 1998
			49	Northcentral GOM	Hoffmayer et al. 2005
Moringidae		*eels	1	Northcentral GOM	Hoffmayer et al. 2005
Mugilidae	*Mugil cephalus*	* striped mullet		North Atlantic/GOM	Coston-Clements et al. 1991
			8	Northcentral GOM	Hoffmayer et al. 2005
	Mugil curema	* white mullet		North Atlantic/GOM	Coston-Clements et al. 1991
			2	Northwestern	Wells and Rooker 2003, 2004 a

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
				GOM	
			777	Northcentral GOM	Hoffmayer et al. 2005
	Mugil sp.		47	Northcentral GOM	Hoffmayer et al. 2005
	Chelon labrosus	Thicklip grey mullet	1591 (NU); 202 (DN)	North Sea	Vandendriessche et al. 2007
Mullidae	*Mullus auratus*	* read goatfish		North Atlantic/GOM	Coston-Clements et al. 1991
	Pseudopeneus maculatus	* spotted goatfish		North Atlantic/GOM	Coston-Clements et al. 1991
	Upeneus parvus	* dwarf goatfish		North Atlantic/GOM	Coston-Clements et al. 1991
	Mullidae sp.	*	34	Northcentral GOM	Hoffmayer et al. 2005
Muraenidae		*Moray eel	22	Northcentral GOM	Hoffmayer et al. 2005
Myctophidae	*Diaphus sp.*	*	28	Northcentral GOM	Comyns et al. 2002, Hoffmayer et al. 2005
	Lampanyctus nobilis	*noble lampfish	1	Northcentral GOM	Hoffmayer et al. 2005
Nomeidae	*Psenes cyanophrys*	* freckled driftfish		North Atlantic/GOM	Coston-Clements et al. 1991
			5	Northwest GOM	Rooker et al. 2006
			14	Northwestern GOM	Wells and Rooker 2003, 2004 a
			13	Northcentral GOM	Hoffmayer et al. 2005

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
	Cubiceps pauciradiatus	*cubiceps	35	Northcentral GOM	Hoffmayer et al. 2005
	Nomeus gronovii	*man of war fish	2	Northcentral GOM	Hoffmayer et al. 2005
	Psenes maculatus	*silver driftfish	1	Northcentral GOM	Hoffmayer et al. 2005
	Psenes pellucidus	Bluefin driftfish	1	Northwestern GOM	Wells and Rooker 2003, 2004
Ogcocephalidae		*angler fish	1	Northcentral GOM	Hoffmayer et al. 2005
Ophichthidae		*eel	29	Northcentral GOM	Hoffmayer et al. 2005
Ophididae		*	3	Northcentral GOM	Hoffmayer et al. 2005
Ostraciidae	*Lactophrys sp.*	boxfish		North Atlantic/GOM	Coston-Clements et al. 1991
			1	Northcentral GOM	Hoffmayer et al. 2005
Paralepidae	*Paralepis atlanticus*	*	1	Northcentral GOM	Hoffmayer et al. 2005
Phycidae	*Urophycis sp*	*	4	Northcentral GOM	Hoffmayer et al. 2005
Pleuronectidae	*Pleuronectidae sp.*	flatfish	3 (NU)	North Sea	Vandendriessche et al. 2007
Polynemidae	*Polydactylus virginicus*	* barbu		North Atlantic/GOM	Coston-Clements et al. 1991
Pomacanthidae	*Holocanthus bermudensis*	*blue angelfish	1	Northcentral GOM	Hoffmayer et al. 2005
Pomacentridae	*Abudefduf saxatilis*	* sergeant major		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991
			3.00-DN (%	Gulf	Moser et al. 1998

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
			MRA)		
			1	Northwest Atlantic Ocean	Stoner and Greening 1984
			555	Northwestern GOM	Wells and Rooker 2003, 2004 a
			101	Northcentral GOM	Hoffmayer et al. 2005
			5	Northwest GOM	Rooker et al. 2006
	Abudefduf taurus	* night sergeant		North Atlantic/GOM	Coston-Clements et al. 1991
	Pomacentrus variabilis	* cocoa damselfish		North Atlantic/GOM	Coston-Clements et al. 1991
Priacanthidae	*Pristigenys alta*	* short bigeye		North Atlantic/GOM/Gulf Stream	Coston-Clements et al. 1991
			0.33-DN (% MRA)	Gulf Stream off Cape Hatteras, North Carolina	Moser et al. 1998
			1	Northwestern GOM	Wells and Rooker 2003, 2004 a
	Priacanthus arenatus	*atlantic bigeye	3	Northcentral GOM	Hoffmayer et al. 2005
Rachycentridae	*Rachycentron canadum*	* Cobia		North Atlantic/GOM	Coston-Clements et al. 1991
			2	Northcentral GOM	Hoffmayer et al. 2005
Scaridae		*parrotfish	22	Northcentral GOM	Hoffmayer et al. 2005
Scombridae	*Acanthocybium solandri*	* wahoo		North Atlantic/GOM	Coston-Clements et al. 1991, Rooker et al. 2004

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
			3	Northwestern GOM	Turner and Rooker 2006
			10	Northwest GOM	Rooker et al. 2006
	Auxis thazard	frigate mackerel		North Atlantic/GOM	Coston-Clements et al. 1991
			829	Northcentral GOM	Hoffmayer et al. 2005
	Auxis rochei	*bullet tuna	42	Northcentral GOM	Hoffmayer et al. 2005
	Auxis sp.		26	Northcentral GOM	Hoffmayer et al. 2005
	Euthynnus alletteratus	little tunny		North Atlantic/GOM	Coston-Clements et al. 1991
			324	Northcentral GOM	Hoffmayer et al. 2005
			5	Northwest GOM	Rooker et al. 2006
	Katsuwonus pelamis	skipjack tuna		North Atlantic/GOM	Coston-Clements et al. 1991
			3	Northcentral GOM	Hoffmayer et al. 2005
	Scomber japonicus	* chub mackerel		North Atlantic/GOM	Coston-Clements et al. 1991
	Scomberomorus cavalla	king mackerel		North Atlantic/GOM	Coston-Clements et al. 1991, Rooker et al. 2004
			2	Northcentral GOM	Hoffmayer et al. 2005

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
			6	Northwest GOM	Rooker et al. 2006
	Scomberomorus maculatus	*	7	Northcentral GOM	Hoffmayer et al. 2005
	Thunnus albacares	*yellowfin tuna		North Atlantic/GOM	Coston-Clements et al. 1991, Rooker et al. 2004
			11	Northcentral GOM	Hoffmayer et al. 2005
			7	Northwest GOM	Rooker et al. 2006
	Thunnus atlanticus	*blackfin tuna		North Atlantic/GOM	Coston-Clements et al. 1991, Rooker et al. 2004
			41	Northcentral GOM	Hoffmayer et al. 2005
			12	Northwest GOM	Rooker et al. 2006
	Thunnus thynnus	*atlantic bluefin tuna	14	Northcentral GOM	Hoffmayer et al. 2005
	Thunnus sp.		149	Northcentral GOM	Hoffmayer et al. 2005
	Scombridae sp.	*	2 (Larvae per $100m^{3)}$	North Central GOM	Comyns et al. 2002
Scophthalmidae	*Scophthalmus maximus*	Turbot	4 (NU)	North Sea	Vandendriessche et al. 2007
Scorpaenidae		*scorpion fish		GOM	Comyns et al. 2002
			3	Northcentral GOM	Hoffmayer et al. 2005
Serranidae	*Epinephelus inermis*	* marbled grouper		North Atlantic/GOM	Coston-Clements et al. 1991
	Centropristis sp.	*	1	Northcentral GOM	Hoffmayer et al. 2005
	Serranus sp.	*	6	Northcentral GOM	Hoffmayer et al. 2005
Soleidae	*Solea solea*	Common sole	14 (NU)	North Sea	Vandendriessche et al. 2007

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
Sparidae	*Pagrus pagrus*	* red porgy		North Atlantic/GOM	Coston-Clements et al. 1991
Sphyraenidae	*Sphyraena barracuda*	* great barracuda		North Atlantic/GOM	Coston-Clements et al. 1991
			106	Northcentral GOM	Hoffmayer et al. 2005
	S. borealis	* northern sennet		North Atlantic/GOM	Coston-Clements et al. 1991
			7	Northcentral GOM	Hoffmayer et al. 2005
	Sphyraena guachancho	* Guachanche barracuda	1	Northcentral GOM	Hoffmayer et al. 2005
	Sphyraenidae sp.	*	13 (Larvae per $100m^{3)}$	North Central GOM	Comyns et al. 2002
			3	Northcentral GOM	Hoffmayer et al. 2005
Stomiiformes		*dragonfish	2	Northcentral GOM	Hoffmayer et al. 2005
Stromateidae	*Centrolophus sp*	ruff		North Atlantic/GOM	Coston-Clements et al. 1991
	Cubiceps pauciradiatus	bigeye cigarfish		North Atlantic/GOM	Coston-Clements et al. 1991
	Hyperoglyphe bythites	black driftfish		North Atlantic/GOM	Coston-Clements et al. 1991
	Hyperoglyphe perciformes	barrel fish		North Atlantic/GOM	Coston-Clements et al. 1991
	Peprilus triacanthus	* butterfish		North Atlantic/GOM	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
	Psenes spp.			Gulf Stream	Moser et al. 1998
			10.20-CC; 8.84-ROV(% MRA)	Stream off Cape Hatteras, North Carolina	Moser et al. 1998
Syngnathidae	*Hippocampus erectus*	* lined seahorse		North Atlantic/GOM	Coston-Clements et al. 1991
			1	Northwestern GOM	Wells and Rooker 2003, 2004 a
	Hippocampus reidi	*longsnout seahorse		North Atlantic/GOM	Coston-Clements et al. 1991
	Hippocampus guttulatus	Long-snouted seahorse	2 (NU)	North Sea	Vandendriessche et al. 2007
	Microphis brachyurus	*opposum pipefish		North Atlantic/GOM	Coston-Clements et al. 1991
	Syngnathus acus	Greater pipefish	7 (NU); 2 (DN)	North Sea	Vandendriessche et al. 2007
	Syngnathus floridae	* dusky pipefish		North Atlantic/GOM	Coston-Clements et al. 1991
	Syngnathus louisianae	*chain pipefish		North Atlantic/GOM	Coston-Clements et al. 1991
			1096	Northwestern GOM	Wells and Rooker 2003, 2004 a
			28	Northcentral GOM	Hoffmayer et al. 2005
			5	Northwest GOM	Rooker et al. 2006
	Syngnathus	*sargassum		North	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
	pelagicus	pipefish		Atlantic/GOM	
			13 (2.44 g)	N. of Bermuda	Burns and Teal 1973
			2	Northwest Atlantic Ocean	Stoner and Greening 1984
			25	Northwest GOM	Wells and Rooker 2003, 2004 a
			18	Northcentral GOM	Hoffmayer et al. 2005
			5	Northwest GOM	Rooker et al. 2006
	Syngnathus rostellatus	Nilsson's pipefish	28 (NU); 7 (DN)	North Sea	Vandendriessche et al. 2007
	Syngnathus scovelli		1	Northwestern GOM	Wells and Rooker 2003, 2004 a
	Syngnathus springeri	* bull pipefish		North Atlantic/GOM	Coston-Clements et al. 1991
	Entelurus aequorius	Snake pipefish	6 (DN)	North Sea	Vandendriessche et al. 2007
	Nerophis lumbriciformis	Worm pipefish	1 (DN)	North Sea	Vandendriessche et al. 2007
Synodontidae		*lizardfish	6	Northcentral GOM	Hoffmayer et al. 2005
Tetraodontidae	*Chilomycterus antennatus*	bridled burrfish		North Atlantic/GOM	Coston-Clements et al. 1991
	Chilomycterus schoepfi	striped burrfish		North Atlantic/GOM	Coston-Clements et al. 1991
	Diodon holocanthus	* ballonfish		North Atlantic/GOM	Coston-Clements et al. 1991
	Diodon hystrix	* porcupinefish		North	Coston-Clements et al. 1991

Family	Species	Common Name	Abundance/ Biomass	Location	Citation
				Atlantic/GOM/Gulf Stream	
			0.33-DN (% MRA)	Stream off Cape Hatteras, North Carolina	Moser et al. 1998
			1	Northwest Atlantic Ocean	Stoner and Greening 1984
	Sphoeroides spp.	* puffers		North Atlantic/GOM	Coston-Clements et al. 1991
			6	Northcentral GOM	Hoffmayer et al. 2005
	Sphoeroides parvus		7	Northwestern GOM	Wells and Rooker 2003, 2004 a
Trachinidae	*Echiichthys vipera*	Lesser weever	45 (NU)	North Sea	Vandendriessche et al. 2007
Trichiuridae	*Unidentified*	* snake mackerel		North Atlantic/GOM	Coston-Clements et al. 1991
	Trichiurus lepturus	*largehead hairtail	15	Northcentral GOM	Hoffmayer et al. 2005
Triglidae		*sea robin	2	Northcentral GOM	Hoffmayer et al. 2005
Xiphiidae	*Xiphias gladius*	* swordfish		North Atlantic/GOM	Coston-Clements et al. 1991
			41	Northern GOM	Wells and Rooker 2009

Table 4. Marine bird species recorded in pelagic Sargassum. Density or biomass are reported when available. Total counts by species are also reported in some studies; however, in many cases a sampling volume or area was not recorded (note we are attempting to turn these into densities with further work).

Species	Common Name	Number of Individuals	Location	Citation
Pterodroma hasitata	Black-capped Petrel	86	South Atlantic Bight	Haney 1986
Calonectris diomedea	Cory's Shearwater	243	South Atlantic Bight	Haney 1986
Puffinus gravis	Greater Shearwater	4	South Atlantic Bight	Haney 1986
Puffinus lherminieri	Audubon's Shearwater	158	South Atlantic Bight	Haney 1986
Oceanites oceanicus	Wilson's Storm-Petrel	331	South Atlantic Bight	Haney 1986
Oceanodroma leucorhoa	Leach's Storm-Petrel	35	South Atlantic Bight	Haney 1986
Oceanodroma castro	Band-rumped Storm-Petrel	4	South Atlantic Bight	Haney 1986
Phaethon lepturus	White-tailed Tropicbird	10	South Atlantic Bight	Haney 1986
Phaethon aethereus	Red-billed Tropicbird	1	South Atlantic Bight	Haney 1986
Sula dactylatra	Masked Booby	9	South Atlantic Bight	Haney 1986
Sula leucogaster	Brown Booby	2	South Atlantic Bight	Haney 1986
Phalaropus lobatus	Red-necked Phalarope	33	South Atlantic Bight	Haney 1986
Phalaropus fulicaria	Red Phalarope	2	South Atlantic Bight	Haney 1986
Phalaropus sp.	Phalarope sp.	33	South Atlantic Bight	Haney 1986
Stercorarius pomarinus	Pomarine Jaeger	4	South Atlantic Bight	Haney 1986
Stercorarius parasiticus	Parasitic Jaeger	1	South Atlantic Bight	Haney 1986
Stercorarius sp.	Jaeger sp.	5	South Atlantic Bight	Haney 1986
Larus argentatus	Herring Gull	12	South Atlantic Bight	Haney 1986
Sterna maxima	Royal Tern	2	South Atlantic Bight	Haney 1986
Sterna hirundo	Common Tern	13	South Atlantic Bight	Haney 1986

Species	Common Name	Number of Individuals	Location	Citation
Sterna paradisaea	Arctic Tern	8	South Atlantic Bight	Haney 1986
Sterna sp.	"Comic" Tern	15	South Atlantic Bight	Haney 1986
Sterna antillarum	Least Tern	2	South Atlantic Bight	Haney 1986
Sterna anaethetus	Bridled Tern	298	South Atlantic Bight	Haney 1986
Sterna fuscata	Sooty Tern	1	South Atlantic Bight	Haney 1986
Chlidonias niger	Black Tern	173	South Atlantic Bight	Haney 1986

Connectivity

A critical but understudied ecosystem service provided by floating *Sargassum* is ecosystem connectivity (Figure 5). Shoreward advection and deposition, sinking and horizontal advection (transport through the Gulf and Atlantic) all represent mechanisms for connectivity. Sinking and deposition of *Sargassum* in benthic environments, particularly in the deeper ocean, may represent an important nutrient subsidy to oligotrophic benthic systems (Schoener and Rowe 1970). *Sargassum* has been found and photographed on the sea floor up to depths of around 5000 meters (Johnson and Richardson 1977). A time-at-depth relationship exists in which bladder failure occurs and sinking begins. If buoyancy is lost, *S. natans* and *S. fluitans* will slowly begin to sink and will reach the sea floor in approximately 40 hours and reach a depth of 5000 m in 2 days (Johnson and Richardson 1977, Schoener and Rowe 1970). *Sargassum* most likely sinks at Langmuir circulations and convergence zones when downwelling velocities exceed 4.5 cm sec-1 (Woodcock 1950). Shoreward advection and deposition also provides a nutrient subsidy to a relatively oligotrophic system-sandy shore beaches. The use of this rack community by invertebrates and in turn shorebirds that feed upon them is well established; however, in many areas such "nuisance" seaweed is removed and sent to landfills (Williams et al. 2008).

In the most comprehensive study of satellite derived imagery of floating Sargassum, Gower and King (2011) provided evidence for a "conveyor belt" of *Sargassum* between the two

basins. Based on the sequence of maximum appearance of *Sargassum* in the GOM and North Atlantic (Figure 4), they concluded that *Sargassum* originates in the western GOM in the spring and is advected towards the eastern GOM. The algae are then transported via the Gulf Loop Current and the Gulf Stream into the North Atlantic basin (Gower and King 2011). The biological community that develops within *Sargassum* may raft along the path (Thiel and Gutow 2005) and repeatedly re-develop along the course. Rafting by biota on floating material likely increases dispersal ability and hence connectivity (Fine 1970, Thiel and Gutow 2005). If the floating material follows some predictable and recurring patterns, then a corridor of connectivity may be established.

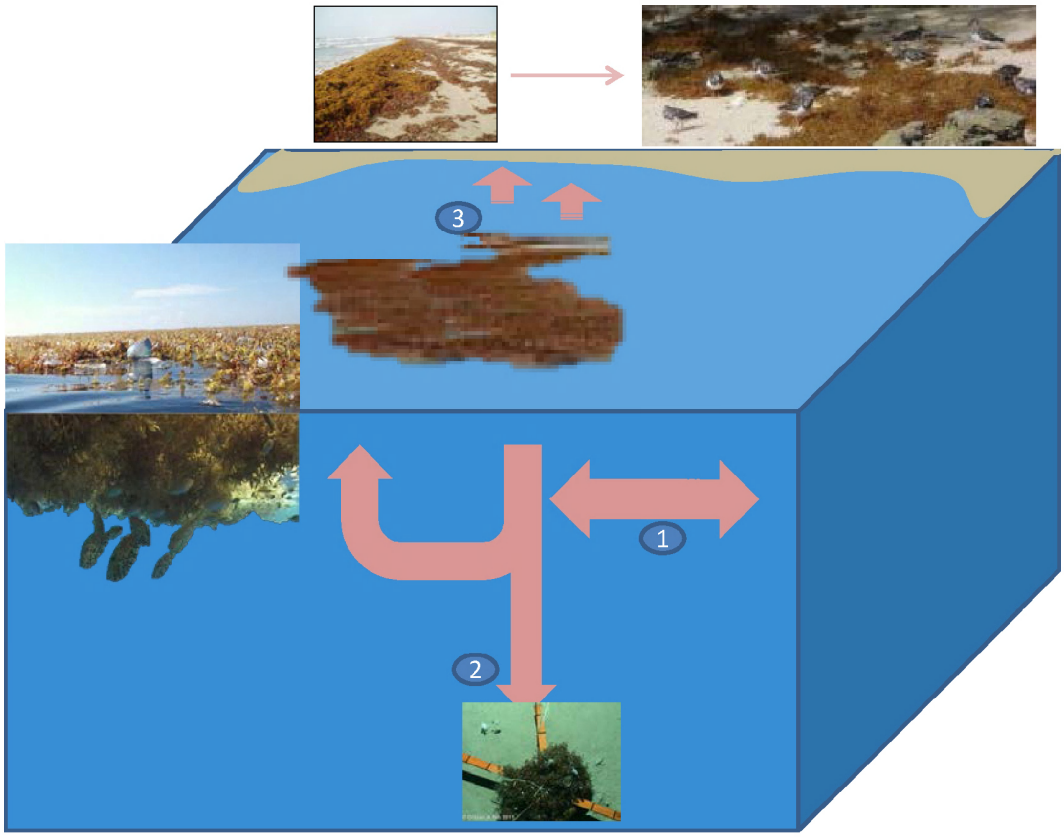

Figure 5. Schematic diagram illustrating connectivity routes from floating *Sargassum:* (1) *Sargassum* is advected throughout the GOM and into the North Atlantic Ocean serving to connect fish and invertebrate populations; (2) sinking of *Sargassum* provides a nutrient subsidy to the oligotrophic ocean bottom community; and (3) *Sargassum* is advected and deposited onto

the sandy shore system where the rack community serves as foraging habitat for terrestrial species.

Sargassum and oiling

No studies appear in the peer-reviewed literature on toxicity of oil to *S. natans* and *S. fluitans*. Several studies have documented tar balls in floating *Sargassum* mats in the GOM, North Atlantic and Caribbean (Table 5), but to date no studies of toxicity of these tar balls have been published in the peer-reviewed literature. Some authors have attempted to estimate the quantity of tar in pelagic *Sargassum* and estimates range from 0.1 to 5.6 mg m^{-2} (Cordes et al. 1980, Joyce 1998, Morris 1971). The range of these values is similar to surface measurements collected in open water areas (Sleeter et al. 1974, 1976, Van Vleet et al. 1984). In a general survey not associated with any spill, Burns and Teal (1973) reported the presence of petroleum hydrocarbons in *S. natans* tissue at relatively low concentrations (< 1ppm) although the ability of the analytical methods to separate natural from petroleum hydrocarbons is rather suspect.

Although no toxicity studies have been published for *S. natans* and *S. fluitans*, several field assessments of impacts to other brown algae following oil spills as well as a limited number of toxicity tests have been published. These studies support a generic model of necrosis of tissue following physical coating of oil, greater sensitivity of young stages (zygotes) to oil and chemical dispersants, reproductive impairment at a range of oil and dispersant concentrations, and a less predictable pattern of sublethal responses of mature plants to lower oil concentrations (i.e. non-coating levels). In their review, Stepanyan and Voskoboinikov (2006) found that most algae (e.g. brown, green and red) undergo decreased photosynthesis and increased respiration under acute oil impacts, although some algae (i.e. *F. vesiculosus*) may have the capability of adapting to continuous impacts of oil. At a cellular level, oil and dispersants affect protein content, DNA, and RNA levels (Stepanyan and Voskoboinikov, 2006). The majority of field assessments have focused on the response of sessile fucoid (i.e. within the order Fucales) algae to oil spill or clean up activities following oil spills. Wrabel and Peckol 2000 found growth inhibition of *Fucus vesiculosus* after a one-day application of the lowest concentration tested (10

ppm of No. 2 Fuel oil) and a clear dosage effect. The high sensitivity of *F. vesiculosus* to oiling led the authors to conclude that this alga may serve as an effective indicator species of oil contamination. Johnston (1977) found that 5 mg of North Sea crude oil/liter significantly reduced growth of *Fucus serratus* zygotes. Similarly, 1-2 ml liter $^{-1}$ of No. 2 fuel oil caused some toxicity on zygotes of *F. edentatus* with a complete kill occurring at 20 ml liter $^{-1}$ (Steele 1977). Following the *Exxon Valdez* oil spill, settlement of *F. gardneri* zygotes in the lower intertidal zones of Prince William Sound were initially lower at oiled locations and attained similar settlement rates of unoiled locations after 3 years. In the upper intertidal zones of the same region, settlement rates had not reached those of unoiled sites after 3 years (van Tamelen et al. 1997). In a separate study of the *Exxon Valdez* spill, *F. gardneri* thalli showed evidence of reduced reproductive fitness in oiled locations compared to non-oiled sites (Stekoll and Deysher 2000). Although most studies support the conclusion of significant effects to *Fucus* from oil exposure, several field-based assessments of oil impacts have also reported relatively minor effects. Following the *Prestige* oil spill off the northwest coast of Spain, no critical decrease in the abundance of *Fucus spp.* was observed (Lobon et al. 2008). Similarly, oil was found to have a negligible effect on *F. vesiculosus* and *Pylaiella littoralis* in the Gulf of Finland (Kotta et al. 2007). Nelson (1982) found minimal negative impacts on *F. vesiculosus* and no significant effects of the *Amoco Cadiz* spill were found on the production of brown algae (Gundlach et al. 1983).

Longer term effects to *Fucus* stands have also been reported from a combination of acute mortality, clean up activities, and disruption of annual recruitment cycle. Driskell et al. (2000) in their study of recovery of the perennial brown alga *Fucus gardneri* in intertidal areas following *Exxon Valdez* Oil Spill reported high mortality from oil exposure with initial recovery within three years, but delayed injury via disruption in annual recruitment cycles (> 10 years). It important to note that Driskell et al. (2000) primary focus of the study was effects on *Fucus* from high pressure washing of the shoreline in Prince William Sound. Southward and Southward (1978) also reported large-scale acute injury of a fucoid algae in the intertidal following the *Torrey* Canyon Oil Spill and an extended recovery period (15 yrs) as a result of disruption in consumer – plant interactions resulting from the oil spill (see Hawkins and Southward 1992,

Burrows and Hawkins 1998). Southward and Southward (1978) also suggested enhanced toxicity of oil when mixed with dispersants for a variety of algae species, including fucoid algae.

In addition to *Fucus* spp., other algae within the order Fucales, have shown measurable adverse effects to oil exposure. Adult *Ascophyllum nodosum* plants exposed to weathered crude oil experienced a short period of reduced growth and necrotic damage before recovering several weeks later (Sjøtun and Lein 1993). Bokn (1987) showed that a small continual dose of diesel oil reduces the growth of *A. nodosum*. Burridge and Shir (1995) demonstrated that the addition of four different Corexit dispersants to a water soluble fraction of diesel fuel resulted in increased inhibition of germination for *Phyllospora comosa*. In contrast, the addition of oil dispersants to crude oil resulted in an increase in germination (Burridge and Shir 1995).

Studies of kelp (*Laminaria* and *Macrocystis)*, brown algae species within the same taxonomic class (Phaeophyceae) as *Sargassum*, have demonstrated significant negative impacts of oil and dispersants on recruitment and growth (Table 6). Diesel fuel from the *Tampico Maru* oil tanker crash at a concentration of 0.1% almost completely stopped photosynthesis in young parts of the *Macrocystis* for three days (Clendenning and North 1960). Khromov and Prokhovov 1979 as well as Prokhorova (1982), reported inhibition of photosynthesis in *Laminaria* and *Fucus* species resulting from exposure to diesel fuel and lubricant. Floc'h and Diouris (1980) have shown that brown algae residing in high tide levels suffered from pronounced plant loss three months after oiling from the *Amoco Cadiz spill* and measurable recovery did not occur for at least eight months. They also reported that *Laminaria ochroleuca* became green within a few hours of oiling and eventually became necrotic.

Although variability in types of oil studied and locations of assessments introduces some uncertainty, the overall consensus from the literature would support a model that physical coating of *Sargassum* with oil would cause substantial, acute injury to *Sargassum* and that lower levels of oil could reasonably be expected to cause inhibition of photosynthesis, respiration and growth.

Table 5. Summary of relevant tar ball or oil studies involving *Sargassum*.

Species	Type of contaminant	Location	Summary	Citation
S. natans	Petroleum Hydrocarbons	Central North Atlantic	Sargassum and associated fauna contaminated with petroleum hydrocarbons. Animals had a higher concentration of petroleum to natural hydrocarbons than the *Sargassum*.	Burns and Teal 1973
Sargassum sp. (pelagic)	Tar/hydrocarbons	Gulf Stream off of Georgia	No tar was found within 40 km of the shore. All samples more than 40 km offshore contained some tar. The mean concentration was 0.82 mg m^{-2} with a range of 0.01-5.6 mg m^{-2}. Tar clung to *Sargassum* weed and tar was higher in concentrations when *Sargassum* is present, probably due to the clinging nature of the tar. Langmuir currents affect *Sargassum* and oil distribution.	Cordes et al. 1980
	Tar	Western North Atlantic and Caribbean	The Northern Sargasso Sea had the greatest density of surface tar with a geometric mean density of 0.99 mg m^{-2}. Floating tar is reported to be 1.88 mg m^{-2} for the northern Sargasso sea and 0.56 mg m^{-2} for the Caribbean. Tar is leaving the area faster than it is coming in. Sargassum and tar distribution is affected by Langmuir currents.	Joyce 1998
Sargassum sp. (pelagic)	Pelagic tar	Northwestern Atlantic and Mediterranean Sea	At a wet weight of 1mg/square meter of ocean surface, and estimated 7 x 10^3 tons of pelagic tar would be in the Sargasso sea or a disturbing amount of 0.1 % (by weight) of tar to *Sargassum* weed. The mean quantity of tar from the N. Atlantic is 0.93 mg m^{-2} and for the Mediterranean it is 19.6 mg m^{-2}.	Morris 1971

Species	Type of contaminant	Location	Summary	Citation
Sargassum sp. (pelagic)	Tar balls, floating liquid oil	North Atlantic	Many oil/tar particles were trapped in S*argassum* weed. Fish eggs, barnacles and hydroids adhered to oil/tar. No large tar balls were found and tar collected ranged from 0.35-20 mm diameter.	Wellman 1973
	Pelagic tar-fresh	Caribbean and equatorial Atlantic	Black, sticky, fresh tar in Caribbean was collected and found in large amounts as well as in the Canary current region (1.4 mg m^{-2} and 2.0 mg m^{-2}, respectively). Equatorial Atlantic had less tar than the other regions (0.16 mg m^{-2}).	Sleeter et al. 1976
	Pelagic tar	Eastern GOM	Concentrations in this region are substantially higher than other regions reported around the world. Tar is primarily associated with the Gulf Loop Current. The overall two-year average for pelagic tar concentrations was (1.48 + 4.74 mg m^{-2}) wet weight, (0.89±2.94 mg m^{-2}) dry weight, (0.78±2.66 mg m^{-2}) toluene extractable lipid, range (0-45.27 mg m^{-2}) wet weight.	Van Vleet et al. 1984
	Pelagic tar clumps	Western Sargasso sea and North Atlantic	Large amounts of tar are concentrated by Langmuir currents. Floating tar clumps ranged from 6.0-16.0 mg m^{-2}.	Sleeter et al. 1974

Table 6. Summary of findings for studies examining oil impacts on brown algae species.

Species	Pollution	Methods	Concentration	Synthesis	Citation
Ascophyllum nodosum	Weathered crude oil	Mesocosm Exp.		Short period of reduced growth and necrotic damage for several weeks.	Sjotun and Lein 1993
	Diesel	Mesocosm Exp.		Reduced growth.	Bokn 1987
Brown Algae	Light crude oil, *Amoco Cadiz*	Field Assessment		Algae in high tide levels suffered pronounced plant loss 3 months after oiling and lasted 8 months.	Floc'h and Diouris 1980
Fucus spp.	Prestige oil spill	Field Assessment		No critical decrease in abundance.	Lobon et al. 2008
Fucus edentatus	No. 2 fuel oil	Lab Experiments	1-2 ml liter^{-1} & 20 ml liter^{-1}	Caused toxicity to zygotes at low densities and a complete zygote kill occurred at high densities.	Steele 1977
Fucus gardneri	Crude oil, *Exxon Valdez*	Field Assessment		Settlement of zygotes decreased in intertidal zones; settlement started to recover after 3 yrs in lower intertidal but had not in the upper intertidal.	van Tamelen et al. 1997
	Crude oil, *Exxon Valdez*	Field Assessment		Thalli not as capable of reproduction in oiled locations as to non-oiled locations.	Stekoll and Deysher 2000

Species	Pollution	Methods	Concentration	Synthesis	Citation
Fucus serratus	Crude oil	Lab Experiments	5mg/liter	Crude oil reduced the growth of *F. serratus* zygotes.	Johnston 1977
Fucus spiralis	Bunker C oil	Field Assessment		Heavy mortality and unsuccessful colonization.	Thomas 1977
Fucus vesiculosus		Review Paper		Algae has the capability to adapt to continuous impacts of oil toxicants.	Stepanyan and Voskoboinikov 2006
		Field Assessment, Finland		Minor effects.	Kotta et al. 2007
Fucus and Laminaria	Diesel fuel/lubricant	Lab Experiments		Toxic to the algae and prevented photosynthesis.	Prokhorova 1982, Khromov and Prokhovov 1979
Laminaria ochroleuca	Light crude oil, *Amoco Cadiz*	Field Assessment		Algae became green within a few hours of oiling and then turned necrotic.	Floc'h and Diouris 1980
Macrocystis	Dark diesel oil	Lab Experiments	0.10%	Photosynthesis of young parts were stopped for almost 3 days after oiling.	Clendenning and North 1960

Fucus vesiculosus		Review Paper		Algae has the capability to adapt to continuous impacts of oil toxicants.	Stepanyan and Voskoboinikov 2006
Pelvetia canaliculata	Light crude oil, *Amoco Cadiz*	Field Assessment		Recolonization began to occur two and a half years after oiling.	Floc'h and Diouris 1980
Phylaiella littoralis		Field Assessment, Finland		Negligible effects.	Kotta et al. 2007
Phyllospora comosa	Corexit dispersants/Diesel fuel/Crude oil	Lab Experiments		Dispersants and diesel fuel inhibited germination while dispersants and crude oil increased germination.	Burridge and Shir 1995

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Appendix. Additional Resources

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