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A Review of Blue Crab Predators

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Abstract. — The diverse life history stages, abundance, and wide distribution over a variety of habitats are attributes that expose blue crabs (*Callinectes sapidus* Rathbun) to numerous predators. An extensive literature search was undertaken on food habits of marine and estuarine invertebrate, and vertebrate species to identify predators of blue crab zoea, megalopae, and juvenile/adults. Ninety-three species, which included invertebrates, fish, reptiles, birds, and mammals, were documented to prey upon blue crabs. An additional 119 species had other crab species or brachyuran remains in their stomach contents. More fish species were identified as blue crab predators than any other taxonomic group (67), and 60 fish species were documented to prey upon unidentified crabs and/or brachyurans. The red drum was the highest ranked predator based upon a predation index of estuarine fish predators.

KEY WORDS: blue crab, predators, red drum

The distribution, life history, and biology of the blue crab (*Callinectes sapidus* Rathbun) make it a preferred prey item for a number of vertebrate and invertebrate predators. The blue crab is one of the most abundant estuarine macroinvertebrates, distributed throughout the Atlantic coast and Gulf of Mexico from Massachusetts to northern Argentina, including Bermuda and the Antilles (Williams, 1974). Life history stages of blue crabs include planktonic, nektonic, and benthic forms that occur throughout the estuarine and nearshore marine environments (Guillory et al., in review). Crab zoeae are found in oceanic and lower estuarine habitats, while megalopae are more widely distributed, occurring in both oceanic and nearshore habitats. Juvenile and adult blue crabs occur throughout the estuary, ranging from fresh/estuarine [from 305 km upstream in the Atchafalaya River in Louisiana (Gunter, 1938)] to shallow/oceanic waters [to depths of 90 m (Franks et al., 1972)].

Several factors contribute to the high diversity of species that utilize blue crabs as a food source. Morgan (1989) suggested that the zoeae of blue crabs are generally smaller with shorter spines than other estuarine crabs rendering them more vulnerable to small planktivorous fish and invertebrates. Energetically, blue crabs are less desirable than fish or shrimp (0.8 calories per gram

wet weight) but more so than molluscs, ctenophores, or barnacles (Thayer et al., 1973). Finally, blue crabs are less able to escape predation than are other prey like fish and shrimp due to poor mobility.

Interspecific and intraspecific predation is recognized as a major source of natural mortality of blue crabs regulating abundances of early stage blue crabs. Orth and van Montfrans (1990) considered predator diversity and density to be important influences on the regional trends observed in juvenile blue crab populations. Several authors have documented extremely heavy predation pressure in tethering experiments (Smith, 1990; Ruiz et al., 1993; Dittel et al., 1995; Hines and Ruiz, 1995). Greater diversity of predators, fewer predation-free refuges, and year-round predation activity all contribute to high mortality of early crabs in the Gulf of Mexico (Heck and Coen, 1995).

While numerous species have been documented to utilize blue crab as prey (Norse, 1975; Van Engel, 1987; Steele and Perry, 1990), a comprehensive list of predators has not been compiled. In order of priority, the objectives of this paper are first to document known vertebrate and invertebrate predators of blue crabs (including zoea, megalopae, juveniles, and adults) and second to rank certain estuarine predators of juvenile blue crabs.

BLUE CRAB PREDATORS

Blue Crab Predators

The occurrence of blue crabs in stomach contents of some predators has been well documented; however, for this report only one source was cited for each predator species. Literature from the Gulf of Mexico were emphasized, although other literature were also included to illustrate the diversity of potential predators. Ninety-three individual species, three genera, and two larger taxonomic groups were documented as predators of blue crab zoeae, megalopae, juveniles, or adults (Appendix 1), and an additional 119 species have been verified to prey upon other brachyurans or crabs (Appendix 2).

Six species have been verified to prey upon blue crab zoeae or megalopae (Appendix 1). While there are few specific reports of predation on blue crab larvae, several species or taxonomic groups have been alluded to as predators of larvae: plankters, fish, jellyfish and comb jellies (Van Engel, 1958); and various clupeids (McHugh, 1967; Millikin and Williams, 1984). Unidentified crab or brachyuran zoeae and megalopae were also identified in the stomachs of 51 species, including eight invertebrates, 39 fishes, one reptile, and one bird (Appendix 2).

A total of 88 species has been identified as predators of juvenile or adult blue crabs (Appendix 1) while 97 species have been reported to prey upon crabs, brachyurans or *Callinectes* (Appendix 2). Four species of invertebrate predators were documented (Appendix 1) and an additional twelve invertebrate predators had unidentified crab or brachyuran remains in their stomachs (Appendix 2). Sixty-seven species of fish were documented to prey upon blue crabs (Appendix 1) while an additional 60 fish species contained prey items categorized as crabs, crab remains, or *Callinectes* (Appendix 2).

Higher vertebrate species which specifically prey on blue crabs include three reptile species, eleven species and three genera of birds, and three mammal species (Appendix 1). In addition, four reptile, sixteen bird, and six mammal species reportedly preyed upon unidentified crabs or crabs in general (Appendix 2). Although not included in the appendices, Neill (1958) noted that freshwater or inland frogs and lizards, which are normally insectivorous, occasionally preyed upon crabs and other marine organisms in brackish, intertidal

habitats.

Although our list of predators includes a taxonomically and ecologically diverse array of species, many other potential predators of blue crabs exist based upon their feeding behavior and co-occurrence with blue crabs. For example, all fish larvae are selective plankton feeders (Hunter, 1980) and could, therefore, prey upon blue crab larvae. In addition, the foraging habits of many marine species have yet to be determined suggesting a strong potential for additional blue crab predators not included on either list (Appendix 1 and 2).

Ranking of Predators

A quantitative ranking of all blue crab predators is not possible due to inadequate abundance and foraging data. Estuarine fish were selected that are important blue crab predators. The predation indices for these species were calculated from the product of the following variables: *abundance* (as calculated from Louisiana Department of Wildlife and Fisheries, LDWF fishery independent gill and trammel net samples); *average weight* (calculated from LDWF samples); and *frequency of occurrence in diets* (obtained from published literature). The average frequency of occurrence of blue crabs in the diet was <15% [with the exception of red drum, *Sciaenops ocellatus*, (32%) and sea catfish, *Arius felis*, (23%)] (Table 1). Red drum was clearly the dominant predator with a predation index 4.8 times greater than the next highest ranked species. Sea catfish, black drum (*Pogonias cromis*), sheepshead (*Archosargus probatocephalus*), and spotted seatrout (*Cynoscion nebulosus*) had the next highest predation indices.

Predation intensity varies with size and species of predator, its life history stage, feeding habits, residency in the estuary, and tolerance to environmental parameters (Van Engel, 1987). The higher ranked predators were epibenthic and common in the shallow estuarine habitats such as intertidal flats, bayous, and ponds in the interior marshes and the fringes of the larger bays and lakes where early juvenile blue crabs are most abundant. Several species of freshwater and marine fish with restricted areal distributions or low numerical abundance also prey heavily on blue crabs and may be locally important predators in some estuaries (Table 2).

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TABLE 1. — Abundance index and average weight from Louisiana Department of Wildlife and Fisheries gill and trammel net samples, average percent frequency of blue crabs in stomachs, and predation index of selected fish. Abundance index = average percent by numbers; predation index = abundance index x average weight x percent frequency of occurrence of blue crabs [1=Arnoldi (1978), 2=Boothby and Avault (1971), 3=Darnell (1958), 4=Fontenot and Rogillio (1970), 5=Fox and White (1969), 6=Guillory and Prejean (2001), 7=Gunter (1945), 8=Kemp (1949), 9=Lambou (1961), 10=Levine (1980), 11=Lorio and Schafer (1966), 12=Miles (1949), 13=Overstreet and Heard (1978a), 14=Overstreet and Heard (1978b), 15=Overstreet and Heard (1982), 16=Rogillio (1975), 17=Seagle (1969), and 18=Stokes (1977)].

Species	Abundance Index	Average Weight	% Frequency (Literature)	Predation Index
red drum	9.9	1.72	32(2,4,6,7,10,13, 16)	545
sea catfish	12.6	0.38	23 (3,7,10)	110
black drum	9.0	0.53	7(3,4,7,8,10,15, 16)	33
sheepshead	4.0	0.94	7(3,4,7,10,12,16)	26
spotted seatrout	12.2	0.40	5(1,3,4,7,10,11, 15,16,17)	24
gafftopsail catfish	0.6	0.65	7 (8,10,12)	3
Atlantic croaker	3.4	0.12	4 (3,4,10,14,16)	2
southern flounder	1.3	0.36	3 (5,7,12,15,16)	1
silver perch	0.7	0.08	2 (3,10)	<

Smaller blue crabs are subject to higher predation rates than are larger blue crabs. Guillory and Prejean (2001) found that almost half of blue crabs consumed by red drum were between 10 mm CW and 29 mm CW, and 78% were <50 mm CW. Blue crabs are also highly cannibalistic, and in some size classes blue crabs comprise as much as 13% of the diet (Darnell, 1958). Mansour (1992) found that cannibalism was common and noted that its frequency increased with increasing crab size and rates were high during the period of juvenile recruitment. Con-specific predation during periods of high small crab abundance led Peery (1989) to suggest that the potential of larger crabs to cannibalize juveniles is great enough to produce strong density-dependent regulation of juveniles.

In summary, 67 fish species were identified as blue crab predators and comprised the largest taxonomic group. An additional 60 fish species were documented to prey upon unidentified crabs, and/or brachyurans. Numerous other species have the potential to be predators of blue crabs and are also listed. Clearly these lists are not comprehensive and additional species will be listed as more predators are documented.

References

Allen, R.P. 1938. Black-crowned night heron colonies on

Long Island. Proc. Linnean Soc. New York 49(1937):43-51.

Arnoldi, D.C. 1978. Certain aspects of the life history and habits of the spotted seatrout in Calcasieu Lake, Louisiana. Louisiana Wildlife and Fisheries Commission, Ann. Rep. Proj. F-32.

Audubon, J.J. 1840. The birds of America. Abbeville Press, New York.

Auster, P.J. and R.E. Dequorsey. 1994. Winter predation of blue crabs, *Callinectes sapidus* by starfish, *Asterias forbesi*. J. Shellfish Res. 13(2):361-366.

Austin, H.M. and S.E. Austin. 1971. The feeding habits of some juvenile marine fishes from the mangroves in western Puerto Rico. Caribbean J. Sci. 11(3/4):171-178.

Bailey, J. 1971. The little blue crab. Ranger Rick's Nat. Mag. 5(10):37-39.

Barass, A.N. and C.L. Kitting. 1982. Responses of *Callinectes sapidus*, blue crabs, to recorded group feeding vocalizations of *Sterna* terns and *Larus articilla* gulls. Am. Zool. 22(4):853.

Bateman, H.A. 1965. Clapper rail (*Rallus longirostris*) studies on Grand Terre Island, Jefferson Parish, Louisiana. M. S. Thesis. Louisiana State University, Baton Rouge.

Batts, B.S. 1972. Food habits of the skipjack tuna, *Katsuwonus pelamis*, in North Carolina waters. Ches. Sci. 13(3):193-200.

Bayliff, W.H., Jr. 1950. The life history of the silverside

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TABLE 2. — Occurrence of blue crabs in stomach contents of fishes with restricted areal distributions or low numerical abundance (%F=percent frequency of occurrence).

Species	Occurrence
<i>Carcharhinus leucas</i> , bullshark	%F = 15 (Kemp, 1949) Blue crabs most numerous prey in young (Sadowsky, 1971).
<i>Carcharhinus plumbeus</i> , sandbar shark	%F = 41 (Gunter, 1945) %F = 80 for pups and young juveniles (Stillwell and Kohler, 1992).
<i>Galeocerdo cuvier</i> , tiger shark	%F = 42 (Kemp, 1949).
<i>Sphyrna tiburo</i> , bonnethead	2.5 blue crabs/fish (Gunter, 1945) <i>Callinectes</i> spp. are the most important prey (Hoesé and Moore, 1958).
<i>Lepisosteus oculatus</i> , spotted gar	%F = 31 (Darnell, 1958; Goodyear, 1967; Knapp, 1951)
<i>Lepisosteus spatula</i> , alligator gar	%F = 31 (Darnell, 1958; Gunter, 1945; Goodyear, 1967; Knapp, 1951)
<i>Anguilla rostrata</i> , American eel	68% by volume (Wenner and Musick, 1975).
<i>Ictalurus furcatus</i> , blue catfish	%F = 15 (Darnell, 1958; Lambou, 1961; Levine, 1980).
<i>Ictalurus punctatus</i> , channel catfish	%F = 10 (Levine, 1980).
<i>Strongylura marina</i> , Atlantic needlefish	%F = 36 (Schwartz and Dutcher, 1963).
<i>Opsanus tau</i> , oyster toadfish	%F = 36 (Schwartz and Dutcher, 1963).
<i>Micropterus salmoides</i> , largemouth bass	%F = 21 (Darnell, 1958; Lambou, 1961).
<i>Morone mississippiensis</i> , yellow bass	%F = 27 (Darnell, 1958; Lambou, 1961).
<i>Morone saxatilis</i> , striped bass	%F = 18 (Darnell, 1958).
<i>Rachyantron canadum</i> , cobia	%F = 42 (for <i>Callinectes</i> sp.) (Knapp, 1951).

- Menidia menidia* (Linnaeus). Chesapeake Biol. Lab., Publ. No. 90.
- Bebee, W. and J. Tee-Van. 1973. The fishes of Port-au-Prince, Haiti, with a summary of the known species of marine fish of the island of Haiti and Santo Domingo. *Zoologica*, 10(1):1-279.
- Bent, A.L. 1925. Life histories of North American birds. Waterfowl. Part 2. U.S. National Museum, Bulletin.
- Bent, A.C. 1962a. Life histories of North American shore birds. Part I. Dover Publications, Inc. New York.
- Bent, A.C. 1962b. Life histories of North American shore birds. Part II. Dover Publications, Inc. New York.
- Bigelow, H.G. and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. *Fish. Bull.* 83:1-577.
- Bingham, B.L. and L.J. Walters. 1989. Solitary ascidians as predators of invertebrate larvae: evidence from gut analyses and plankton samples. *J. Exp. Mar. Biol. Ecol.* 131:147-159.
- Bjorndal, K.A. 1997. Foraging ecology and nutrition of sea turtles. Pages 199-231 in: P.L. Lutz and J.A. Musick (eds.). *The Biology of Sea Turtles*. CRC Press, Boca Raton, FL.
- Bohkle, J.E. and C.C. Chaplin. 1971. Fishes of the Bahamas and adjacent tropical waters. Livingston Publishing Co. Wynnewood, PA.
- Boothby, R.N. and J.W. Avault, Jr. 1971. Food habits, length-weight relationship, and condition factor of the red drum (*Sciaenops ocellata*) in southeastern Louisiana. *Trans. Am. Fish. Soc.* 100:290-295.
- Bortone, S.A. 1971. Studies on the biology of the sand perch, *Diplectrum formosum* (Perciformes: Serranidae). Florida Department of Natural Resources, Mar. Res. Lab. Tech. Ser. No. 65.
- Brooks, H.A., J.V. Merriner, C.E. Myers, J.E. Olney, G.W. Boehlert, J.V. Lascara, A.D. Estes, and T.A. Munroe. 1982. Higher level consumer interactions. Chapter 4. Pages 1-196 in: Final Report: Structural and Functional Aspects of the Biology of Submerged Aquatic Macrophyte Communities in the Lower Chesapeake Bay. Virginia Institute of Marine Science, Spec. Rep. 267.
- Bruger, G.E. 1974. Age, growth, food habits, and reproduction of bonefish, *Albula vulpes*, in South Florida waters. Florida Department of Natural Resources, Mar. Res. Publ. No. 3.
- Bull, J. and J. Farrand, Jr. 1977. The Audubon Society field guide to North American birds. Alfred A. Knopf, Inc. New York.
- Bullock, L.H. and G.B. Smith. 1991. Sea basses (Pisces: Serranidae). Florida Department of Environment Quality Marine Lab, Mem. Hourglass Cruises 8(2):1-243.
- Burnett, F.L. and D.E. Snyder. 1954. Blue crabs as starvation food of oiled American eiders. *Auk* 71(3):315-316.
- Caldwell, D.K., M.C. Caldwell, and D.W. Rice. 1966. Behavior of the sperm whale, *Physeter catodon*. Pages 677-717 in: K.S. Norris (ed.). *Whales*,

GUILLORY AND ELLIOT

- Dolphins, and Porpoises. University of California Press, Berkeley.
- Carr, W.E. and C.A. Adams. 1972. Food habits of juvenile marine fishes: evidence of the cleaning habit in the leatherjacket, *Oligoplites saurus*, and the spottail pinfish, *Diplodus holbrooki*. Fish. Bull. 70(4):1111-1120.
- Carr, W.E. and C.A. Adams. 1973. Food habits of juvenile marine fishes occupying seagrass beds in the estuarine zone near Crystal River, Florida. Trans. Am. Fish. Soc. 102:511-540.
- Chabreck, R.H., J.E. Holcombe, R.G. Linscombe and N.E. Kinler. 1982. Winter foods of river otters from saline and fresh environments in Louisiana. Proc. Ann. Conf. Southeast Assoc. Fish Wildl. Agencies 36:473-484.
- Clark, E. and K. von Schmidt. 1965. Sharks of the central Gulf Coast of Florida. Bull. Mar. Sci. 15(1):12-83.
- Dahlberg, M.D. and R.W. Heard, II. 1969. Observations on elasmobranchs from Georgia. Quart. J. Fla. Acad. Sci. 32(1):21-25.
- Darnell, R.M. 1958. Food habits of fishes and larger invertebrates of Lake Pontchartrain, Louisiana, an estuarine community. Publ. Inst. Mar. Sci. Univ. Texas 5:353-416.
- Day, J.W. Jr., W.G. Smith, P.R. Wagner, and W.C. Stone. 1973. Community structure and carbon budget of a salt marsh and shallow bay estuarine system in Louisiana. Louisiana State University Center for Wetland Resources, Publ. SG-72-04.
- Diener, R.A., A. Inglis, and G.B. Adams. 1974. Stomach contents of fishes from Clear Lake and tributary waters, a Texas estuarine area. Contrib. Mar. Sci. 18:7-17.
- Dittel, A.I., A.H. Hines, G.M. Ruiz, and K.K. Ruffin. 1995. Effects of shallow water refuge on behavior and density-dependent mortality of juvenile blue crabs in Chesapeake Bay. Bull. Mar. Sci. 57(3):902-916.
- Divita, R., M. Creel, and P.F. Sheridan. 1983. Foods of coastal fishes during brown shrimp, *Penaeus aztecus*, migration from Texas estuaries (June-July 1981). Fish. Bull. 81(2):396-404.
- Felder, D. 1971. The decapod crustaceans of Seven and One-half Fathom Reef. M.S. Thesis. Texas A&I University.
- Fontenot, B.J. and H.E. Rogillio. 1970. A study of estuarine sportfishes in the Biloxi marsh complex. Louisiana Wildlife and Fisheries Commission, Compl. Rep. Dingell-Johnson Proj. F-8.
- Forbush, E.H. 1912. A history of game birds, wildfowl, and shore birds of Massachusetts and adjacent states. Massachusetts State Board of Agriculture.
- Fox, L.S. and C.J. White. 1969. Feeding habits of the southern flounder, *Paralichthys lethostigma*, in Barataria Bay, Louisiana. Proc. Louisiana Acad. Sci. 32:31-38.
- Franks, J.S., J.Y. Christmas, W.L. Siler, R. Combs, R. Waller, and C. Burns. 1972. A study of nektonic and benthic faunas of the shallow Gulf of Mexico off the state of Mississippi as related to some physical, chemical, and geological factors. Gulf Res. Rep. 4:1-148.
- Goodyear, C.P. 1967. Feeding habits of three species of gars, *Lepisosteus*, along the Mississippi Gulf Coast. Trans. Am. Fish. Soc. 21(3):297-300.
- Green, J. 1968. The biology of estuarine animals. University of Washington, Seattle.
- Grimes, C. 1979. Diet and feeding ecology of the vermilion snapper, *Rhomplites aurorubens* (Cuvier) from North Carolina and South Carolina waters. Bull. Mar. Sci. 29(1):53-61.
- Grinnel, J., H.C. Bryant, and T.I. Storer. 1918. The game birds of California. University of California Press, Berkley. 642 pp.
- Guillory, V., H. Perry, and S. VanderKooy (eds). In review. The blue crab fishery of the Gulf of Mexico, United States: a regional management plan. Gulf States Marine Fisheries Commission, Ocean Springs, Mississippi.
- Guillory, V. and P. Prejean. 2001. Red drum predation on blue crabs. Pages 93-104 in: V. Guillory, H.M. Perry, and S. VanderKooy (eds.). Proceedings of the Blue Crab Mortality Symposium. Gulf States Marine Fisheries Commission. Publ. No. 90.
- Gunter, G. 1938. The common blue crab in fresh waters. Science 87(2248):87-88.
- Gunter, G. 1945. Studies on marine fishes of Texas. Publ. Inst. Mar. Sci. Univ. Texas 1(1):1-190.
- Gunter, G. 1950. Seasonal population changes and distribution as related to salinity, of certain invertebrates of the Texas Coast, including the commercial shrimp. Publ. Inst. Mar. Sci. Univ. Texas 1(2):7-51.
- Hammatt, R.B. 1981. Reproductive biology in Louisiana estuarine heronry. M.S. Thesis. Louisiana State University, Baton Rouge.
- Handley, C.O., Jr. 1966. A synopsis of the genus *Kogia* (pygmy sperm whale). Pages 62-69 in: K.S. Norris (eds.). Whales, Dolphins, and Porpoises. University of California Press, Berkley.
- Hanlon, R.T. 1983. *Octopus joubini*. Pages 293-310 in: P.R. Boyle (ed.). Cephalopod Life Cycles. Volume 1. Species Accounts. Academic Press Inc. New York.
- Harrington, R.W., Jr. and E.S. Harrington. 1961. Food selection among fishes invading a high subtropical salt marsh: from onset of flooding through the progress of a mosquito brood. Ecology 42(4):646-666.

BLUE CRAB PREDATORS

- Hastings, R.W. 1973. Biology of the pygmy sea bass, *Serraniculus pumilio* (Pisces: Serranidae). Fish. Bull. 71(1):235-242.
- Heard, R.W., Jr. 1973. Information on the food and feeding habits of the white catfish, *Ictalurus catus* L., from a Georgia estuary. Unpubl. Rep.
- Heck, K.L., Jr. and L.D. Coen. 1995. Predation and the abundance of juvenile blue crabs: a comparison of selected east and Gulf Coast (USA) studies. Bull. Mar. Sci. 57(3):877-883.
- Hedgpeth, J.W. 1950. Notes on the marine invertebrate fauna of the salt flat areas in Aransas National Wildlife Refuge, Texas. Publ. Inst. Mar. Sci. Univ. Texas 1(2):103-119.
- Hess, P.W. 1961. Food habits in two dasyatid rays in Delaware Bay. Copeia 1961(2):239-241.
- Hildebrand, S.F. 1963. Fishes of the Western North Atlantic. Family Elopidae. Pages 111-131 in: H. Bigelow (ed.). Sears Foundation for Marine Research, Mem. 3.
- Hildebrand, S.F. and W.C. Schroeder. 1923. Fishes of Chesapeake Bay. U.S. Bureau Fisheries Bull. 28(2):1071-1109.
- Hines, A.H. and G.M. Ruiz. 1995. Temporal variation in juvenile blue crab mortality: nearshore shallows and cannibalism in Chesapeake Bay. Bull. Mar. Sci. 57(3):884-901.
- Hoese, H.D. and R.B. Moore. 1958. Notes on the life history of the bonnetnose shark, *Sphyrna tiburo*. Texas J. Sci. 10(1):69-72.
- Hsueh, P., J.B. McClintock, and T.S. Hopkins. 1992. Comparative study of the diets of the blue crab *Callinectes similis* and *C. sapidus* from a mud-bottom habitat in Mobile Bay, Alabama. J. Crust. Biol. 12(4):615-619.
- Hunter, J. and R.J. Feller. 1987. Immunological dietary analysis of two penaeid shrimp species from a South Carolina tidal creek. J. Exp. Mar. Biol. Ecol. 107:61-70.
- Hunter, J.R. 1980. The feeding behavior and ecology of marine fish larvae. Pages 287-330 in: J.E. Bardach (ed.). The Physiological and Behavioral Manipulation of Food Fish as Production and Management Tools.
- Johnson, W.S., D.M. Allen, M.V. Ogburn, and S.E. Stancyk. 1990. Short-term predation responses of adult bay anchovies *Anchoa mitchilli* to estuarine zooplankton availability. Mar. Ecol. Prog. Ser. 64:55-68.
- Kasprzak, R. and V. Guillory. 1984. Food habits of sand seatrout in Barataria Bay, Louisiana. Proc. Ann. Conf. Southeast. Fish Wildl. Agencies 38:480-487.
- Kemp, R.J. 1949. Report on stomach analysis on June 1, 1949 through August 31, 1949. Pages 101-127 in: Texas Game, Fish and Oyster Commission, Mar. Lab Ann. Rep. 1948-1949.
- Knapp, F.T. 1951. Food habits of the sergeantfish, *Rachycentron canadus*. Copeia 1951(1):101-102.
- Knieb, R.T. 1976. Feeding, reproduction, growth and movements of killifishes on a North Carolina salt marsh. M.S. Thesis. University of North Carolina, Chapel Hill.
- Knieb, R.T. and A.E. Stiven. 1978. Growth, reproduction, and feeding of *Fundulus heteroclitus* (L.) on a North Carolina salt marsh. J. Exp. Mar. Biol. Ecol. 31:121-140.
- Lambou, V.W. 1961. Utilization of macrocrustaceans for food by freshwater fishes in Louisiana and its effects on the determination of predator-prey relations. Prog. Fish-Cult. 23:18-25.
- Lane, E.D. 1967. A study of the Atlantic midshipmen, *Porichthys porosissimus*, in the vicinity of Port Aransas, Texas. Publ. Inst. Mar. Sci. Univ. Texas 12:1-53.
- Lascara, J.V. 1981. Fish predator-prey interactions in areas of eelgrass (*Zostera marina*). M. S. Thesis. College of William and Mary, Williamsburg, Virginia.
- Levine, S.J. 1980. Gut contents of Lake Pontchartrain fish species, 1977-1978. Pages 877-1030 in: J. H. Stone (ed.). Environmental Analysis of Lake Pontchartrain, Louisiana, its Surrounding Wetlands, and Selected Wetland Uses. Chapter 14. Louisiana State University Coastal and Wetland Resources, Rep. for U.S. Army Corps Eng. Cont. No. DACW-29-77-C-0253.
- Linton, E. 1905. Parasites of fishes of Beaufort, North Carolina. Bulletin U.S. Bureau of Fisheries (1904) 24:321-428.
- Livingston, R.J. 1982. Trophic organization of fishes in a coastal seagrass system. Mar. Ecol. Prog. Ser. 7:1-12.
- Lorio, W.J. and H.E. Schafer. 1966. A food habit study of spotted seatrout, *Cynoscion nebulosus*, in the Biloxi Marsh area, Louisiana. Proc. Southeast. Assoc. Game Fish Comm. 19:289-296.
- Lowery, G. 1974. The mammals of Louisiana and its adjacent waters. Louisiana State University Press, Baton Rouge.
- Lucas, J.R. 1982. Feeding ecology of the gulf silverside, *Menidia peninsulae*, near Crystal River, Florida, with notes on its life history. Estuaries 5:138-144.
- Mansour, R. A. 1992. Foraging ecology of the blue crab, *Callinectes sapidus* Rathbun, in lower Chesapeake Bay. Ph.D. Diss. College of William and Mary, Williamsburg, VA.
- McAfee, W.L. 1912. Some common game, aquatic, and rapacious birds in relation to man. U.S. Department of Agriculture, Farmers Bull. 497.
- McHugh, J.L. 1967. Estuarine nekton. Pages 581-620 in:

GUILLORY AND ELLIOT

- G.H. Lauff (ed.). Estuaries. Amer. Assoc. Advancement of Science, Publication No. 83.
- McMichael, R.H., Jr., K.M. Peters, and G.R. Parsons. 1989. Early life history of the snook, *Centropomus undecimalis*, in Tampa Bay, Florida. *Northeast Gulf Sci.* 10(2):113-125.
- McMichael, R.H., and S.T. Ross. 1987. The relative abundance and feeding habits of juvenile kingfish (Sciaenidae: *Menticirrhus*) in a Gulf of Mexico surf zone. *Northeast Gulf Sci.* 9(2):109-123.
- Medved, R.W. and J.A. Marshall. 1981. Feeding behavior and biology of young sandbar sharks, *Carcharhinus plumbeus* (Pisces, Carcharhinidae), in Chincoteague Bay, Virginia. *Fish. Bull.* 79:441-447.
- Menzel, R.W. 1943. The catfish industry of Virginia. *Trans. Am. Fish. Soc.* 73:364-372.
- Miles, D.W. 1949. A study of the food habits of the fishes of the Aransas bay area. Pages 129-159 in: Texas Game, Fish and Oyster Commission, Marine Lab Ann. Rep.
- Millikin, M.R. and A.B. Williams. 1984. Synopsis of biological data on the blue crab, *Callinectes sapidus* Rathbun. U.S. Department of Commerce, NOAA Tech. Rep. NMFS 1.
- Modde, T.C. 1979. Characterization of the ichthyofauna occupying the surf zone of a northern Gulf Coast barrier island. Ph.D. Diss. University of Southern Mississippi. Hattiesburg.
- Moody, K.E. 1994. Predation on juvenile blue crabs, *Callinectes sapidus* Rathbun, in lower Chesapeake Bay: patterns, predators, and potential impacts. Ph.D. Diss. The College of William and Mary, Williamsburg, Virginia.
- Morgan, S.G. 1989. Adaptive significance of spination in estuarine crab zoeae. *Ecology* 70:462-482.
- Motta, P.J., K.B. Clifton, P. Hernandez, B.T. Eggold, S.D. Giordano, and R. Wilcox. 1995. Feeding relationships among nine species of seagrasses of Tampa Bay, Florida. *Bull. Mar. Sci.* 56(1):185-200.
- Neill, W.T. 1958. The occurrence of amphibians and reptiles in saltwater areas, and a bibliography. *Bull. Mar. Sci. Gulf Caribb.* 8(1):1-97.
- Nelson, B.D. and S.A. Bortone. 1996. Feeding guilds among artificial-reef fishes in the northern Gulf of Mexico. *Gulf Mexico Sci.* 1996(2):66-80.
- Norse, E.A. 1975. The ecology of blue crabs, genus *Callinectes* (Brachyura: Portunidae) in the Caribbean. Ph.D. Diss. University of Southern California, Los Angeles.
- Oberholser, H.C. 1974. The bird life of Texas. Volume 1. University of Texas Press. Austin, Texas. 530 pp.
- Odum, W. 1971. Pathways of energy flow in a south Florida estuary. Ph.D. Diss. University of Miami, Florida.
- Olmi, E.J., III and R.N. Lipcius. 1991. Predation on postlarvae of the blue crab *Callinectes sapidus* Rathbun by sand shrimp *Crangon septemspinosa* Say and grass shrimp *Palaemonetes pugio* Holthuis. *J. Exp. Mar. Biol. Ecol.* 151:169-183.
- O'Neil, T. 1949. The muskrat in the Louisiana coastal marshes. Louisiana Wildlife and Fisheries Commission, New Orleans.
- Orth, R.J. and J. van Montfrans. 1990. Utilization of marsh and seagrass habitats by early stages of *Callinectes sapidus*: a latitudinal perspective. *Bull. Mar. Sci.* 46(1):126-144.
- Overstreet, R.M. and R.W. Heard. 1978a. Food of the red drum, *Sciaenops ocellata*, from Mississippi Sound. *Gulf Res. Rep.* 6(2):131-135.
- Overstreet, R.M. and R.W. Heard. 1978b. Food of the Atlantic croaker, *Micropogon undulatus*, from Mississippi Sound. *Gulf Research Reports*, 6(2):145-152.
- Overstreet, R.M. and R.W. Heard. 1982. Food contents of six commercial fishes from Mississippi Sound. *Gulf Res. Rep.* 7(2):137-149.
- Peery, C.A. 1989. Cannibalism experiments with the blue crab (*Callinectes sapidus* Rathbun): potential effects of size and abundance. M.S. Thesis. College of William and Mary, Williamsburg, VA.
- Phillips, P.J., W.D. Burke, and E.J. Keener. 1969. Observations on the trophic significance of jellyfishes in Mississippi Sound with quantitative data on the associative behavior of small fishes with medusae. *Trans. Am. Fish. Soc.* 98(4):703-712.
- Powell, E.H., Jr. and G. Gunter. 1968. Observations on the stone crab *Menippe mercenaria* (Say), in the vicinity of Port Aransas, Texas. *Gulf Res. Rep.* 2(3):285-299.
- Reid, G.K., Jr. 1954. An ecological study of the Gulf of Mexico fishes, in the vicinity of Cedar Key, Florida. *Bull. Mar. Sci. Gulf Caribb.* 4(1):1-94.
- Rogers, J.A. Jr. 1982. Food of nestling little blue herons on the west coast of Florida. *Florida Field Nat.* 10:25-30.
- Rogillio, H.E. 1975. An estuarine sportfish study in southeastern Louisiana. Louisiana Department of Wildlife and Fisheries, Fish Bull. No. 14.
- Ropes, J.W. 1989. The food habits of five crab species at Pettaguamscutt River, Rhode Island. *Fish. Bull.* 87(1):197-204.
- Ross, S.W. 1989. Diet of the banded drum in North Carolina. *Trans. Am. Fish. Soc.* 118:680-686.
- Ross, J.L., J.S. Pavela, and M.E. Chittenden, Jr. 1989. Food habits of the rock sea bass, *Centropristis philadelphica*, in the western Gulf of Mexico. *Northeast Gulf Sci.* 10(2):139-152.
- Ruiz, G.M., A.H. Hines, and M.H. Posey. 1993. Shallow water as refuge habitat for fish and crustaceans in nonvegetated estuaries - an example from Chesapeake Bay. *Mar. Ecol. Prog. Ser.* 99(1-2):1-16.

BLUE CRAB PREDATORS

- Sadowsky, V. 1971. Notes on the bull shark *Carcharhinus leucas* in the lagoon region of Cananeia, Brazil. Sao Paulo Bol. Instit. Oceanogr. 20(2):71-78.
- Saloman, C.H. and S.P. Naughton. 1983. Food of Spanish mackerel, *Scomberomorus maculatus*, from the Gulf of Mexico and southeastern seaboard of the United States. U.S. Department of Commerce, NOAA Tech. Memo. MNFS-SEFC-128.
- Schwartz, F.J. and B.W. Dutcher. 1963. Age, growth, and food of the oyster toadfish near Solomons, Maryland. Trans. Am. Fish. Soc. 92(2):170-173.
- Seagle, J.H. 1969. Food habits of spotted seatrout *Cynoscion nebulosus* (Cuvier) frequenting turtle grass (*Thalassia testudinum* Konig) beds in Redfish Bay, Texas. *Taius* 2(1):58-63.
- Sebens, K.P. and M.A.R. Koehl. 1984. Predation on zooplankton by the benthic anthozoans *Alcyonium siderium* (Alcyonacea) and *Metridium senile* (Actiniaria) in the New England subtidal. *Mar. Biol.* 81:25-271.
- Sharp, H.F., Jr. 1967. Food ecology of the rice rat, *Oryzomys palustris* (Harlan), in a Georgia salt marsh. *J. Mammalol.* 48:557-563.
- Sheridan, P.F. 1979. Trophic resource utilization by three species of sciaenid fishes in a northwest Florida estuary. *Northeast Gulf Sci.* 3(1):1-15.
- Sheridan, P.F., D.L. Trimm, and B.M. Baken. 1984. Reproduction and food habits of seven species of northern Gulf of Mexico fishes. *Contrib. Mar. Sci.* 27:175-204.
- Sikora, W.B. and R.W. Heard. 1972. The occurrence and food habits of two species of hake, *Urophycis regius* and *U. floridanus* in Georgia estuaries. *Trans. Am. Fish. Soc.* 101(3):513-525.
- Smith, L.D. 1990. The frequency and ecological consequences of limb autotomy in the blue crab, *Callinectes sapidus* Rathbun. Ph.D. Diss. University of Maryland, College Park.
- Stacy, G., R.O. Smitherman, and J.W. Avault. 1970. Food habits of the bowfin in Lacassine National Wildlife Refuge and other locations in southern Louisiana. *The Prog. Fish. Cult.* 32(3):153-157.
- Starck, W.A., III. 1971. Biology of the gray snapper, *Lutjanus griseus* (Linnaeus) in the Florida Keys. University of Miami, Stud. Tropical Oceanogr. 10:11-150.
- Steele, P. and H. Perry (editors). 1990. The blue crab fishery in the Gulf of Mexico, United States: a regional management plan. Gulf States Marine Fisheries Commission, Publ. No. 21.
- Stehlik, L.A., P.G. Scarlett, and J. Bobarro. 1998. Status of the blue crab fisheries of New Jersey. *J. Shellfish Res.* 17(2):475-485.
- Stephenson, J.O. and R.E. Griffith. 1946. Winter life of the whooping crane. *Condor* 48(4):160-178.
- Stickney, R.R., G.T. Taylor, and R.W. Heard, III. 1974. Food habits of Georgia estuarine fishes. I. Four species of flounders (Pleuronectiformes:Bothidae). *Fish. Bull.* 72(2):515-525.
- Stickney, R.R., G.T. Taylor, and B.B. White. 1975. Food habits of young southeastern United States estuarine Sciaenidae. *Ches. Sci.* 16(2):104-114.
- Stieglitz, W.O. 1966. Utilization of available foods by diving ducks on Apalachee Bay, Florida. *Proc. Southeast. Assoc. Game Fish Comm.* 20:42-50.
- Stillwell, C.E. and N.E. Kohler. 1992. Food habits of the sandbar shark *Carcharhinus plumbeus* off the U.S. northeast coast, with estimates of daily ration. *Fish. Bull.* 91:138-150.
- Stokes, G.M. 1977. Life history studies of southern flounder (*Paralichthys lethostigma*) and gulf flounder (*P. albigutta*) in the Aransas Bay area of Texas. Texas Parks and Wildlife Department, Tech. Ser. 25.
- Stoner, A.W. and B.A. Buchanan. 1990. Ontogeny and overlap in the diet of four tropical *Callinectes* species. *Bull. Mar. Sci.* 46(1):3-12.
- Subrahmanyam, C.B. and S.H. Drake. 1975. Studies on the animal communities in two north Florida salt marshes. *Bull. Mar. Sci.* 25(4):445-465.
- Suttkus, R.D. 1963. Order Lepisosteii. Pages 61-68 in: H. Bigelow (ed.). *Fishes of the Western North Atlantic. Memorial Sears Found. Res., Memoir 3.*
- Thayer, G.W., W.E. Schaff, J.W. Angelovic, and M.W. Lacroix. 1973. Caloric measurements of some estuarine organisms. *Fish. Bull.* 71:289-296.
- Valentine, J.M., J.R. Walther, K.M. McCartney and L.M. Ivy. 1972. Alligator diets on the Sabine National Wildlife Refuge, Louisiana. *J. Wildl. Manage.* 36(3):809-815.
- Van Engel, W.A. 1958. The blue crab fishery in Chesapeake Bay. Part I. Reproduction, early development, growth, and migration. *Comm. Fish. Rev.* 20(6):6-17.
- Van Engel, W.A. 1987. Factors affecting the distribution and abundance of the blue crab in Chesapeake Bay. Pages 177-209 in: S.K. Majumdar, L.W. Hall, Jr., and H.M. Austin (eds.). *Contaminant and Management of Living Chesapeake Bay Resources. The Pennsylvania Acad. Sci.*
- Welsh, W.W. and C.M. Breder, Jr. 1923. Contributions to the life histories of the Sciaenidae of the eastern United States coast. *Bulletin U.S. Bureau Fisheries* 39:141-201.
- Wenner, C.A. and J.A. Musick. 1975. Food habits and seasonal abundance of the American eel, *Anguilla rostrata*, from the lower Chesapeake Bay. *Ches. Sci.* 16(1):62-66.
- Wickersham, C.W. 1902. Sickle-billed curlew. *The Auk* 19:353-356.
- Williams, A.B. 1974. The swimming crabs of the genus *Callinectes* (Decapoda: Portunidae). *Fish. Bull.*

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- he genus
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- 72:685-798.
- Winfrey, R.A. and S. Weinstein. 1989. Food habits of the
Caribbean king crab *Mithrax spinosissimus*
- (Lamarck). Proc. Gulf Caribb. Fish. Inst. 39:458-464.

BLUE CRAB PREDATORS

APPENDIX 1. Documented predators of blue crabs [derived in part from Norse (1975), Van Engel (1987), and Steele and Perry (1990)].

INVERTEBRATES

Jellyfish (Van Engel, 1958) [larvae]
Comb jellies (Van Engel, 1958) [larvae]
Asterias forbesi - starfish (Auster and Degoursey, 1994)
Callinectes sapidus - blue crab (Darnell, 1958)
Crangon septemspinosus - sand shrimp (Olmi and Lipcius, 1991) [megalopae]
Menippe adina - western gulf stone crab (Powell and Gunter, 1968)
Mithrax spinosissimus - Caribbean king crab (Winfrey and Weinstein, 1989)
Palaemonetes pugio - grass shrimp (Olmi and Lipcius, 1991) [megalopae]

FISHES

Carcharhinus leucas - bull shark (Sadovsky, 1971)
Carcharhinus obscurus - dusky shark (Kemp, 1949).
Carcharhinus plumbeus - sandbar shark (Medved and Marshall, 1981)
Galeocerdo cuvier - tiger shark (Kemp, 1949)
Mustelus canis - smooth dogfish (Bigelow and Schroeder, 1953)
Sphyrna tiburo - bonnethead (Hoese and Moore, 1958)
Dasyatis americanus - southern stingray (Dahlberg and Heard, 1969)
Dasyatis centroura - rough-tail stingray (Hess, 1961)
Dasyatis sabina - Atlantic stingray (Darnell, 1958)
Dasyatis sayi - bluntnose stingray (Hess, 1961)
Raja eglanteria - clearnose skate (Hildebrand and Schroeder, 1923)
Lepisosteus oculatus - spotted gar (Lambou, 1961)
Lepisosteus osseus - longnose gar (Suttkus, 1963)
Lepisosteus spatula - alligator gar (Darnell, 1958)
Brevoortia tyrannus - Atlantic menhaden (McHugh, 1967) [larvae only]
Elops saurus - ladyfish (Austin and Austin, 1971)
Megalops atlanticus - tarpon (Hildebrand, 1963)
Albula vulpes - bonefish (Bruger, 1974)
Anguilla rostrata - American eel (Wenner and Musick, 1975)
Arius felis - hardhead catfish (Gunter, 1945)
Arius bonillai - new granada sea catfish (Norse, 1975)
Bagre marinus - gafftopsail catfish (Gunter, 1945)
Ictalurus catus - white catfish (Heard, 1973)
Ictalurus furcatus - blue catfish (Lambou, 1961)
Ictalurus punctatus - channel catfish (Menzel, 1943)
Urophycis regius - spotted hake (Sikora and Heard, 1972)
Opsanus beta - gulf toadfish (Steele and Perry, 1990)
Opsanus tau - oyster toadfish (Schwartz and Dutcher, 1963)
Strongylura marina - Atlantic needlefish (Brooks et al., 1982)
Tylosurus acus - agujon (Brooks et al., 1982)
Fundulus diaphaneus - banded killifish (Stehlik et al., 1998)
Fundulus grandis - gulf killifish (Levine, 1980)
Fundulus heteroclitus, mummichog (Morgan, 1989) [larvae only]
Menidia beryllina - inland silverside (Levine, 1980)
Menidia menidia - Atlantic silverside (Morgan, 1989) [larvae only]
Prionotus tribulus - bighead searobin (Diener et al., 1974)
Morone americana - white perch (Brooks et al., 1982)

GUILLORY AND ELLIOT

APPENDIX 1. Con't

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- Morone mississippiensis* - yellow bass (Lambou, 1961)
Morone saxatilis - striped bass (Darnell, 1958)
Centropristes striatus - black sea bass (Brooks et al., 1982)
Centropristes philadelphica - rock sea bass (Ross et al., 1989)
Epinephelus itajara - jewfish (Kemp, 1949)
Micropterus salmoides - largemouth bass (Lambou, 1961)
Pomatomus saltatrix - bluefish (Brooks et al., 1982)
Rachycentron canadum - cobia (Gunter, 1950)
Caranx hippos - crevalle jack (Steele and Perry, 1990)
Lutjanus apodus - schoolmaster (Austin and Austin, 1971)
Lutjanus campechanus - red snapper (Felder, 1971)
Lutjanus griseus - gray snapper (Starck, 1971)
Lobotes surinamensis - tripletail (Gunter, 1945)
Archosargus probatocephalus - sheepshead (Gunter, 1945)
Lagodon rhomboides - pinfish (Darnell, 1958)
Aplodinotus grunniens - freshwater drum (Darnell, 1958)
Bairdiella chrysoura - silver perch (Darnell, 1958)
Cynoscion arenarius - sand seatrout (Kasprzak and Guillory, 1984)
Cynoscion nebulosus - spotted seatrout (Gunter, 1945)
Cynoscion regalis - weakfish (Lascara, 1981) [larvae also]
Leiostomus xanthurus - spot (Levine, 1980)
Micropogonias undulatus - Atlantic croaker (Darnell, 1958)
Sciaenops ocellatus - red drum (Guillory and Prejean, 2001)
Pogonias cromis - black drum (Gunter, 1945)
Tautoga onitis - tautog (Moody, 1994)
Scomberomorus cavalla - king mackerel (Kemp, 1949)
Ancylopsetta quadrocellata - ocellated flounder (Stickney et al., 1974)
Citharichthys spilopterus - bay whiff (Stickney et al., 1974)
Paralichthys albigutta - gulf flounder (Stokes, 1977)
Paralichthys dentatus - summer flounder (Moody, 1994)
Paralichthys lethostigma - southern flounder (Darnell, 1958)
Sphoeroides maculatus - northern puffer (Van Engel, 1987)
Sphoeroides nephelus - southern puffer (Reid, 1954)

REPTILES

- Alligator mississippiensis* - American alligator (Valentine et al., 1972)
Caretta caretta - loggerhead sea turtle (Van Engel, 1987)
Lepidochelys kempfi - Atlantic ridley (Van Engel, 1987)

BIRDS

- Ardea herodias* - great blue heron (Steele and Perry, 1990)
Articilla spp. - gulls (Day et al., 1973)
Casmerodius albus - great egret (Bailey, 1971)
Florida caerulea - little blue heron (Rogers, 1982)
Guana alba - white ibis (Hammatt, 1981)
Grus americana - sandhill crane (Stephenson and Griffith, 1946)
Larus articilla - laughing gull (Barass and Kitting, 1982)
Larus spp. - gulls (Day et al., 1973)
Lophodytes cucullatus - hooded merganser (Stieglitz, 1966)
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BLUE CRAB PREDATORS

APPENDIX 1. Con't

Mergus merganser - American merganser (Stieglitz, 1966)
Nycticorax nycticorax - black-crowned night heron (Allen, 1938)
Rallus longirostris - clapper rail (Bateman, 1965)
Somateria mollissima - American eider (Burnett and Snyder, 1954)
Sterna spp. - terns (Barass and Kitting, 1982)

MAMMALS

Canis rufus - red wolf (Bill Vermilliod, LDWF, personal communication)
Lutra canadensis - river otter (Chabreck et al., 1982)
Procyon lotor - racoon (Hedgpeth, 1950)

GUILLORY AND ELLIOT

APPENDIX 2. Predators of zoeae, megalopae, or crabs (adopted in part from Van Engel, 1987).

INVERTEBRATES

<i>Alcyonium siderium</i> - alcyonacean octocoral	crab zoeae (Sebens and Koehl, 1984)
<i>Metridium senile</i> - sea anemone	crab zoeae (Sebens and Koehl, 1984)
<i>Chelyosoma productum</i> - ascidian	zoeae (Bingham and Walters, 1989)
<i>Pyura haustor</i> - ascidian	zoeae (Bingham and Walters, 1989)
<i>Boltenia villosa</i> - ascidian	zoeae (Bingham and Walters, 1989)
<i>Herdminia momus</i> - ascidian	zoeae (Bingham and Walters, 1989)
<i>Ascidia curvat</i> - ascidian	zoeae (Bingham and Walters, 1989)
<i>Callinectes bocourti</i> - swimming crab	crabs (Stoner and Buchanan, 1990)
<i>Callinectes danae</i> - swimming crab	crabs (Stoner and Buchanan, 1990)
<i>Callinectes ornatus</i> - swimming crab	crabs (Stoner and Buchanan, 1990)
<i>Callinectes similis</i> - lesser blue crab	brachyuran remains (Hsueh et al., 1992)
<i>Carcinus maenas</i> - green crab	crabs (Ropes, 1989)
<i>Carpilus</i> sp. - xanthid crab	<i>Callinectes</i> (Norse, 1975)
<i>Libinia emarginata</i> - spider crab	crabs (Ropes, 1989)
<i>Ovalipes ocellatus</i> - lady crab	crabs (Ropes, 1989)
<i>Neopanopeus texana</i> - mud crab	crabs (Ropes, 1989)
<i>Penaeus aztecus</i> - brown shrimp	crabs (Hunter and Feller, 1987)
<i>Penaeus setiferus</i> - white shrimp	crabs (Hunter and Feller, 1987)
<i>Chiropsalmus quadrumanus</i> - sea wasps	crab zoeae and megalopae (Phillips et al., 1969)
<i>Octopus joubini</i> - pygmy octopus	crabs (Hanlon, 1983)

FISHES

<i>Carcharhinus limbatus</i> - blacktip shark	crab remains (Clark and von Schmidt, 1965)
<i>Mustelis norrisi</i> - Florida smoothhound	crabs (Clark and von Schmidt, 1965)
<i>Rhizoprionodon terranova</i> - Atlantic sharpnose shark	crabs (Linton, 1905)
<i>Sphyrna mokarran</i> - great hammerhead	crabs (Clark and von Schmidt, 1965)
<i>Squalis acanthias</i> - spiny dogfish	crabs (Hildebrand and Schroeder, 1923)
<i>Gymnura micrura</i> - butterfly ray	crabs (Hildebrand and Schroeder, 1923)
<i>Amia calva</i> - bowfin	crab (Stacy et al., 1970)
<i>Elops saurus</i> - ladyfish	crab zoeae (Harrington and Harrington, 1961)
<i>Megalops atlanticus</i> - tarpon	crab zoeae (Harrington and Harrington, 1961)
<i>Echidna catenata</i> - chain moray	crabs (Bohlke and Chaplin, 1971)
<i>Anchoa mitchilli</i> - bay anchovy	<i>Callinectes</i> spp. zoeae and megalopae (Johnson et al., 1990)
<i>Harengula jaguana</i> - scaled sardine	brachyuran zoeae, megalopae, and crabs (Modde, 1979)
<i>Harengula pensacolatae</i> - scaled sardine	zoeae (Odum, 1971)
<i>Opisthonema oglinum</i> - Atlantic thread herring	crabs (Beebe and Tee-Van, 1973)
<i>Anchoa hepsetus</i> - striped anchovy	megalopae (Carr and Adams, 1973)
<i>Anchoa lyolepis</i> - dusky anchovy	brachyuran zoeae and megalopae (Modde, 1979)
<i>Arius felis</i> - hardhead catfish	brachyuran zoeae, megalopae, and crabs (Modde, 1979)
<i>Urophycis floridana</i> - southern hake	crab larvae (Sheridan et al., 1984)
<i>Porichthys porosissimus</i> - Atlantic midshipmen	crabs (Divita et al., 1983)
<i>Synodus foetens</i> - inshore lizardfish	<i>Callinectes</i> larvae and juveniles (Lane, 1967)
<i>Leopoldidium brevibarbe</i> - blackedge cusk-eel	crabs (Hildebrand and Schroeder, 1923)
	crabs (Divita et al., 1983)

BLUE CRAB PREDATORS

APPENDIX 2. Con't

<i>Hyporhamphus unifasciatus</i> - halfbeak	megalopae (Linton, 1905)
<i>Cyprinodon variegatus</i> - sheepshead topminnow	crabs (Subrahmanyam and Drake, 1975)
<i>Fundulus confluentus</i> - marsh killifish	crab zoeae (Harrington and Harrington, 1961)
<i>Fundulus grandis</i> - gulf killifish	crab zoeae (Harrington and Harrington, 1961)
<i>Fundulus heteroclitus</i> - mummichog	crab zoeae (Harrington and Harrington, 1961)
<i>Fundulus majalis</i> - striped killifish	crabs (Knieb and Stiven, 1978)
<i>Fundulus similis</i> - longnose killifish	crabs (Knieb, 1976)
<i>Floridichthys carpio</i> - goldspotted killifish	crabs and crab larvae (Motta et al., 1995)
<i>Lucania parva</i> - rainwater killifish	crab parts (Motta et al., 1995)
<i>Gambusia affinis</i> - mosquitofish	crab zoeae (Harrington and Harrington, 1961)
<i>Poecilia latipinna</i> - sailfin molly	crab zoeae (Harrington and Harrington, 1961)
<i>Menidia beryllina</i> - tidewater silverside	crab zoeae (Harrington and Harrington, 1961)
<i>Menidia menidia</i> - Atlantic silverside	crab megalopae (Carr and Adams, 1973)
<i>Menidia peninsulae</i> - gulf silverside	crabs (Bayliff, 1950)
<i>Scorpaena calcarata</i> - smoothhead scorpionfish	brachyuran zoeae (Lucas, 1982)
<i>Scorpaena grandicornis</i> - plumed scorpionfish	crabs (Divita et al., 1983)
<i>Prionotus carolinus</i> - northern searobin	<i>Callinectes</i> (Austin and Austin, 1971)
<i>Prionotus rubio</i> - blackwing searobin	crabs (Hildebrand and Schroeder, 1923)
<i>Prionotus scitulus</i> - leopard searobin	crabs (Divita et al., 1983)
<i>Centropomus undecimalis</i> - snook	crabs (Linton, 1905)
<i>Centropristis ocyurus</i> - bank sea bass	zoeae and crabs (McMichael et al., 1989)
<i>Diplectrum formosum</i> - sand perch	crabs (Divita et al., 1983)
<i>Epinephelus morio</i> - red grouper	crabs (Bortone, 1971)
<i>Rypticus maculatus</i> - whitespotted soapfish	crabs (Nelson and Bortone, 1996)
<i>Serraniculus pumilio</i> - pygmy sea bass	crabs (Bullock and Smith, 1991)
<i>Serranus atrobranchus</i> - blackear bass	crabs and crab megalopae (Hastings, 1973)
<i>Serranus subligarius</i> - belted sandfish	crabs (Divita et al., 1983)
<i>Lepomis punctatus</i> - spotted sunfish	crabs (Bullock and Smith, 1991)
<i>Priacanthus arenatus</i> - bigeye	crabs (Levine, 1980)
<i>Echeneis naucrates</i> - sharksucker	crabs (Divita et al., 1983)
<i>Trachinotus carolinensis</i> - pompano	crabs (Divita et al., 1983)
<i>Trachinotus falcatus</i> - permit	brachyuran megalopae and crabs (Modde, 1979)
<i>Coryphaena hippurus</i> - dolphin	crabs (Carr and Adams, 1973)
<i>Lutjanus synagris</i> - lane snapper	crabs (Kemp, 1949)
<i>Rhomboplites aurorubens</i> - vermilion snapper	crabs (Divita et al., 1983)
<i>Diapterus plumieri</i> - striped mojarra	crabs (Grimes, 1979)
<i>Eucinostomus gula</i> - silver jenny	crab zoeae (Harrington and Harrington, 1961)
<i>Conodon nobilis</i> - barred grunt	crab parts (Motta et al., 1995)
<i>Haemulon plumieri</i> - white grunt	crabs (Divita et al., 1983)
<i>Orthopristis chrysoptera</i> - pigfish	crabs (Carr and Adams, 1973)
<i>Diplodus holbrookii</i> - spottail pinfish	crabs (Linton, 1905)
<i>Stenotomus caprinus</i> - longspine porgy	crabs (Carr and Adams, 1972) and crab zoeae (Livingston, 1982)
<i>Bairdiella chrysoura</i> - sand seatrout	crabs and crab larvae (Sheridan et al., 1984)
<i>Cynoscion nothus</i> - silver seatrout	crab zoeae and megalopae (Sheridan, 1979)
<i>Larimus fasciatus</i> - banded drum	crabs and crab larvae (Sheridan et al., 1984)
<i>Leiostomus xanthurus</i> - spot	zoeae and megalopae (Ross, 1989)
<i>Menticirrhus americanus</i> - southern kingfish	brachyuran zoeae and megalopae (Stickney et al., 1975)
<i>Menticirrhus littoralis</i> - gulf kingfish	<i>Callinectes</i> sp., brachyuran megalopae (McMichael and Ross, 1987)
	brachyuran zoeae and crabs (Modde, 1979)

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APPENDIX 2. Con't

	<i>Menticirrhus saxatalis</i> - northern kingfish	<i>Callinectes</i> sp., brachyuran megalopae (McMichael and Ross, 1987)
061)	<i>Micropogonias undulatus</i> - Atlantic croaker	brachyuran megalopae (Stickney et al., 1975)
061)	<i>Stellifer lanceolatus</i> - star drum	crabs (Welsh and Breder, 1923)
061)		brachyuran zoeae and megalopae (Stickney et al., 1975)
	<i>Abudefduf saxatalis</i> - sergeant major	crab zoeae (Linton, 1905)
	<i>Mugil cephalus</i> - striped mullet	crab zoeae (Harrington and Harrington, 1961)
	<i>Chasmodes saburrae</i> - Florida blenny	crabs (Carr and Adams, 1973)
	<i>Paraclinus fasciatus</i> - banded blenny	crabs (Livingston, 1982)
061)	<i>Trichiurus lepturus</i> - Atlantic cutlassfish	crabs and crab larvae (Sheridan et al., 1984)
061)	<i>Katsuwonus pelamis</i> - skipjack tuna	crab megalopae (Batts, 1972)
061)	<i>Scomberomorus maculatus</i> - Spanish mackerel	crab (Saloman and Naughton, 1983)
	<i>Etropus crossotus</i> - bay whiff	crabs (Stickney et al., 1974)
	<i>Monacanthus hispidus</i> - planehead filefish	crabs (Nelson and Bortone, 1996)
	<i>Chilomyceterus schoepfii</i> - striped burrfish	crabs (Linton, 1905)

REPTILES

	<i>Caretta caretta</i> - loggerhead	crab zoeae (Bjorndal, 1997)
	<i>Dermochelys coriacea</i> - leatherback	crabs (Bjorndal, 1997)
	<i>Eretmochelys imbricata</i> - hawksbill	crabs (Bjorndal, 1997)
	<i>Lepidochelys olivacea</i> - olive ridley	crabs (Bjorndal, 1997)

BIRDS

	<i>Ajaia ajaia</i> - roseate spoonbill	<i>Callinectes</i> (Green, 1968)
	<i>Anas acuta</i> - pintail	crabs (Bull and Farrand, 1977)
	<i>Ammospiza maritima</i> - seaside sparrow	crabs (Bull and Farrand, 1977)
	<i>Branta canadensis</i> - canada goose	crabs (Bent, 1925)
	<i>Calidris canutus</i> - American knot	crabs (Bent, 1962a)
		crab larvae (Forbush, 1912)
1979)	<i>Catoptrophorus semipalmatus</i> - willet	crabs (Bent, 1962b)
	<i>Chaulelasmus streperus</i> - egret	crabs (Bull and Farrand, 1977)
	<i>Mareca americana</i> - widgeons	crabs (Day et al., 1973)
	<i>Megaceryle alcyon</i> - belted kingfisher	crabs (Bull and Farrand, 1977)
	<i>Numenius americanus</i> - long-billed curlew	crabs (Wickersham, 1902)
061)	<i>Nyctanassa violacea</i> - yellow-crowned night heron	crabs (Audubon, 1840)
	<i>Oxyechus vociferus</i> - killdeer	crabs (McAfee, 1912)
	<i>Plegadis falcinellus</i> - glossy ibis	crabs (Bull and Farrand, 1977)
	<i>Squatarola squatarola</i> - black-billed plover	crabs (Grinnel et al., 1918)
	<i>Sterna maxima</i> - royal tern	crabs (Oberholser, 1974)
oeae	<i>Sterna nilotica</i> - gull-billed tern	crabs (Oberholser, 1974)

MAMMALS

4)	<i>Logia breviceps</i> - pygmy sperm whale	crabs (Handley, 1966)
3)	<i>Mustela vison</i> - North American mink	crabs (Lowery, 1974)
4)	<i>Ondatra zibethicus</i> - common muskrat	crabs (O'Neil, 1949)
ey et al.,	<i>Oryzomys palustris</i> - marsh rice rat	crabs (Sharp, 1967)
McMichael	<i>Physeter catodon</i> - sperm whale	crabs (Caldwell et al., 1966)
)	<i>Tursiops truncatus</i> - bottlenose dolphin	crabs (Kemp, 1949)