Food and Feeding Habits of fishes

The food of fish consists principally of plant and animal groups which live in water or near it, in addition to some chemical elements that can fish absorb it from water directly such as calcium. Fishes, like other animals, require the common components of food: proteins, carbohydrates, fats, minerals, vitamins and water.

Food habits mean the type of food which the fish eat.

Feeding habits means the behavior of nutrition, or the way by which the fish obtain the food.

The food habits

Feeding and searching for food are factors which regulate or at least influence the distribution, migration and growth of fish.

Knowledge of the food habits and diets of a fish species provides a key to the understanding of many aspects of fish biology, physiology and behavior. From the ecological point of view such studies allow investigation of trophic interactions between and within species, namely predator-prey relationships and competition. Studies of the distribution and relative abundance of prey, together with information on environmental parameters and feeding habits aid the identification of migratory patterns and of feeding grounds both locally and regionally. Feeding habits studies also have direct implications for fishing gears such as longlines and fish traps which use bait. Knowledge of daily feeding activity cycles, feeding grounds and prey preferences can be used to select baits and to optimize fishing strategy.

Feeding is one of the most important functions of an organism. Other basic function of an organism, which includes growth, development, reproduction, all require adequate nutrition and all these functions take place at the expense of the energy. All the other energy processes within the organism also proceed at the expense of the food

The first stage in the life cycle of a fish is completed at the expense of the food reserves, which it receives from the maternal organism (the yolk in the egg).After the depletion of food substances stored in yolk sac, fish larvae start to depend on themselves in feeding. At first, fishes start feeding on bacteria, small green algae, diatoms and microorganisms either plants or animals. It can be said that fish during their early life are omnivorous. By advancing in growth and reaching the stage of maturity, the specialization is started to appear that some fish become specialized to great extent and depend on very fixed types of food.

There are europhagic fish which feed upon a variety of different types of food. There are also stenophagic fish which feed upon certain selected kinds of food, and monophagic fish which feed upon single type of food. Some fish spend the length of their lives as omnivorous, live on plants and animal organisms such as carp (*Cyprinus carpio*) and *clarias* spp. This fish is able to feed upon benthic insects and small invertebrates in addition to plants, and can feed upon small fish. This mode of nutrition made this fish to be dominant in the aquatic environment in which it was introduced. There is another type of fish which is specialized to great extent to become herbivorous such as, Tilapia spp.and the vegetative carp (*Ctenopharyngodon idella*) which feed widely upon the rooted plants. Some fish start their lives as plankton feeder and stay as it is the rest of their lives such as paddle fish. These fish need some modification to help in filtration the minute plankton. Others feed on animals and are termed carnivorous, for example, *lates niloticus*. Other fish are also

become specialized parasitic fishes such as the seas lamprey, *Petromyzon marinus*.

A wide range of kinds and sizes of plants and animals are important in the food chain of fishes. Among the plants are the algae and higher plants. The algae are of many forms, they could be planktonic, and others associated with a substrate like some kind of entophytes, epiphytes, or even epizoophytes. Examples of algae include euglena, volvox and Naicula. Among the earliest animals foods to be consumed by fishes is animal's plankton organism (zooplankton) and these includes different kinds of protozoan, micro crustaceans and other macroscopic vertebrate and the eggs of many insects and animals. No particular food is constantly available to fishes all the year around and this is primarily due to the great changes in the composition of food organism and their availability. Such fluctuation are often cyclic and due to factors of their life histories or to climatic or other environmental conditions for example, insect intend to emerge to a peak level at the onset of rainy season, and so those fishes that feed mainly on insects tend to accomplish most of the annual growth during this season while at the other seasons they feed on the most available food. Authors observed that availability and abundance are the key factors in feeding habits of fishes as most fishes are highly adaptable in what they eat utilizing the most readily available foods.

The more stable the feeding condition of the species, the smaller the range of food to which it is adapted and conversely, the more variable the food supply, the greater the variety of food eaten by the species.

The different organisms upon which the fish feed occupy different regions or sites in the aquatic environment. The more important these regions are:

1- The benthic region: such as the rooted plants, immature stages of insects, worms and mollusks.
2- The pelagic region: such as plankton and the organisms feed upon it.
3- The region of direct subsurface water: occupied by mosquitoes larvae.
4- The region of surface water: occupied by earth insects falling on water, and toads.
5- The region of direct super surface water: occupied by numerous aquatic insects such as mosquitoes.

Many fishes show a decrease in the feeding rate as the temperature drops. Poorer feeding intensity in winter is probably related to lower sea water temperature in the study area, which slowly lowers the metabolism, and thereby further results in reduced feeding. Intensified feeding throughout summer is probably due to higher temperature, which stimulate metabolism and increase food demands.

The main food items of *Oreochromis niloticus* and *O. aureus* in Lake Mariut consists of diatoms, algae, vegetable matter and flagellates. The seasonal variations in feeding intensity of these fishes indicated a maximum feeding intensity in summer but a minimum one in winter. The feeding intensity is correlated to water temperature. Some authors indicated that water temperature and not photoperiod affects the feeding activity of tilapia.

The European eel, *Anguilla Anguilla*, from lake Manzala, Egypt feed on fish, Chironomidae larvae, Crustacea, Odonata larvae and Mollusca. Eel displays seasonal variation in feeding rate. The fish showed active feeding in spring and autumn. The rate of feeding decreased in summer and was very low in winter. The feeding rate of

eel decrease with increasing size, a negative correlation was found between length and the feeding index. Eels alter their type of diet as they grow. Eels change from an invertebrate to a fish diet as they get older.

The food of the European eel, *Anguilla anguilla*, in Polish lakes had diverse diet consisting of more than 20 items including vertebrates and invertebrates species.The food of eels consisted mainly of fish, Chironimidae, Asellus aquaticus, Gastropoda, and Trichoptera. The food of eels changed according to the season. The food composition of eels changed according to the body size of this fish. Eels smaller than 50.0 cm fed exclusively upon invertebrates, while eels longer than 70.0 cm fed mainly upon fish. The number of empty stomachs had a distinct tendency to increase with the eel increasing size.

The percentage of full stomachs and feeding index showed that feeding period of eels in Polish lakes is restricted to the summer months, and that they did not feed at all during winter months. Although water temperature had an important effect on feeding activity, it cannot be considered the sole factor influencing the feeding intensity.
The food of eels differed according to the shape of their heads. The broad-headed eels fed more on fish, while narrow-headed ones fed more on invertebrate fauna.

The feeding activity of the Japanese eel, *Anguilla japonica*, in the tropical Taiwan was higher in winter but lower in summer as indicated from the seasonal changes in the feeding activity and condition factor. The reasons were probably due to the abundance of prey organism in the streams of Taiwan was small and water temperature was too high in the summer. The eel was omnivorous and opportunistic feeder, feeding mainly on Oligochaeta, Hirudinea, aquatic insects, plant

fragments and seed. The diet composition of Japanese eel changed with eel size.

Studying the food habits of sea bass, *Dicentrarchus labrax*, in the Egyptian waters revealed that Crustaceans, fish and polychaetes form its main food groups. The feeding activity of this fish was higher during summer months, while it was greatly decreased during winter months. The majority of authors found that there is a direct relation between diet composition of bass and the abundance of food organisms present in the same habitat, i.e. bass is not selective to certain food species. Spawning does not affect feeding activity of bass.

Analysis of stomach content of *Pagellus erythrinus* in the Egyptian Mediterranean waters showed that crustaceans, polychaetes and teleosts, cephalopods and brittle stars constitute the main food items.

The food of *Diplodus sargus* and *Diplodus vulgaris* from Abu Qir Bay consisted of crustacea (amphipoda, isopoda and prawn),fish, polychaeta and echinoderms. In addition to those food items, the stomachs of *D. sargus* contained Mollusca (bivalves and gastropods) and algae. Interspecific competition between the two species revealed that *D. sargus* is in search for bivalves, while *D. vulgaris* is in search of polychaeta and isopoda. Five indices were studied to determine the preferential food items for each species. Bivalves were the preferred food items for *D.sargus*, while polychaetes were the preferred for *D. Vulgaris*. Seasonal variations studies on *D. sargus* showed that echinoderms appeared in spring only, while amphipoda and isopoda appeared in spring and summer only. The diet of *D.sargus* varied with the fish size, the abundance of polychaeta decreased with increasing the fish size, while the highest occurrence in larger fish was for fish and prawn.

The diet of *D. sargus* varied slightly with sex. Prawn had the highest values of occurrence in the stomachs of males and females, while polychaeta had the highest occurrence in the stomachs of hermaphrodites. In conclusion, both *Diplodus sargus* and *Diplodus vulgaris* feed on the same food items and each species search for certain food item.

In Lake Qarun, T. zillii (Gerv.) are filter feeding fish, it consumes mainly net phytoplankton of Lake Qarun. Approximately Bacillariophyceae and Dinophyceae were dominated the fish diet. However, other classes (Chlorophyceae, Cyanophyceae, Euglenophyceae and Cryptophyceae) were observed in comparatively few numbers in the guts of the selected fish. Diatoms and dinoflagellates are very important food items for *Oreochromis niloticus* , however Cyanophyceae occupied the third prominent position as food for such fish. *Solea vulgaris* preys heavily upon dinoflagellate *Prorocentrum micans*. Moreover, this fish showed a special preference to diatoms species. Adult mullets are known to be benthic and diurnal feeder and feed mainly on Zooplankton. On the basis of frequency occurrence (FO) and average number, most common fishes of Lake Qarun prefer diets diatoms and dinoflagellates. It is very interest to close fishing season and transplant fish fry during the blooming period to enhance phytoplankton grazing by filter feeding fishes.

Studying the food habit of barracudas from the Egyptian Mediterranean water off Alexandria revealed that fishes were the most important food items eaten by these fishes of all size groups.

The African catfish, *Clarias gariepinus* from an Ethiopian lake is considered to have a carnivorous feeding habit. The fish ingested a wide variety of food items of animal origin which included insects, zooplankton, fish, mollusks, nematodes and fish eggs.

The food habits of the common two-banded sea bream, *Diplodus vulgaris*, from the eastern Adriatic revealed that the maximum number of empty stomachs was recorded during the autumn (35.5%) and a minimum number was recorded during the summer (4.5%). A total of 42 different prey species belonging to eight major groups: Echinoidea, Decapoda, Bivalvia, Gastropoda, Polychaeta, Mysidacea, Polyplacophora and Amphipoda were identified in stomach contents. Echinoidea constituted the main prey (%IRI = 40.9), especially for fish less than 25.0 cm TL. With fish growth, the proportion of echinoids decreased while that of decapods crustaceans and bivalves increased. Diet composition showed a seasonal variation; the lowest intensity of feeding was recorded during spawning (autumn) as well as in a period of lower sea temperature (winter). The results indicate that the common two-banded sea bream feeds on a wide range of prey items and can be considered an opportunistic predator.

Changes in the species composition of the stomach contents were related to several factors:

1- Relative abundance and degree of concealment of prey.

2- Average and range in length of prey

3- Motility and escape reaction of prey

4- Hunting behavior and efficiency of the fish

5- Turbidity of water

The methods used in studying the food habits

These include simply the identification of food by studying the contents of fish alimentary canal. These studies must cover the different months and seasons.

1- **The numerical method**: The number of individuals in each food category is recorded for each stomach and for all stomachs in monthly or seasonally samples. The food items are arranged according to their number and the obtained picture give indication to the importance of each food. The total number of food items may be expressed as a proportion usually a percentage of the total individuals in all food categories. This method is appropriate where prey items of different species are in the same size range, e.g. in piscivorous fishes or planktonivorous fishes.

Numerical method overemphasizes the importance of small prey items taken in large numbers. For many stomachs it is difficult to estimate number in each category because of mastication of the food, especially in cyprinids, before it reaches the stomach, and the effect of digestive process. This method is not suitable for dealing with food items such as macro algae and detritus which do not occur in discrete units.

2- **Frequency of occurrence method**: The number of stomachs in which each food items occurs is expressed as a percentage of the total number of stomach examined. This method yields very valuable information on the prevalence of food items, provided food items are readily identifiable. In addition to this, it is quick and requires the minimum of apparatus. On the other hand, this method neglected the quantitative side, and some food items gain a high percentage of occurrences due to their resistance to digestion. Despite this, the method provides a somewhat crude qualitative picture of the food spectrum.

3- **Gravimetric method**: it consists of the estimation of the weight of each of the food items, which is usually expressed as a percentage of the weight of the total stomach contents. The weight of food may be determined wet or dry. Wet weight is probably the more convenient measure; dry weight estimation is more time-consuming as is usually employed where accurate determination of calorific intake is required.

Dry weight gives a lower error margin in bulk determination of the food of planktonivorous fishes. Dry weight is obtained by evaporating water until constant weight is achieved. When wet weight determination are made, surface water is most often removed from prey items by blotting them on tissue paper, however, the variation in the amount of moisture removed has been identified as a major source of error in weight measurements. This method give a reasonable estimate of bulk and, in the case of larger prey items, are relatively easy to apply, they have the advantage of being applicable to almost all prey items. On the other hand, this method is usually considered to overemphasize the contribution of single heavy items to the diet.

4- **Volumetric method** : The displacement method is probably the most accurate one for assessing the volume. The volume of each food item is measured by displacement in a graduated container such as a cylinder with the smallest possible diameter for accuracy. The total volume of a food category taken by the fish sample is usually given as a percentage of the total volume of all stomach contents. This method is eminently suited in the estimation of the food of carnivorous fishes. A major problem with use of this method is that the water trapped within the item may cause large errors in the estimate. Excess water can be removed by blotting items on filter paper before volume determination.

5- **Restoration the original properties of food :** To overcome the advantage resulting from the difference in the speed of food item digestion, the original volume of this item is restored. For example, if the stomach contained a complete crustacean animal and remains of digested fish, the crustacean animal may have a weight or volume more than the remains fish by using the volumetric or gravimetric method. This method proposes taking the original volume or weight of

the crustacean animal and fish. The work by this method require long time, the author must go back to environment and know the approximate volumes and weights of organisms which forms food of the studied fish.

6- **Point method**: The stomach of each fish in the sample is investigated and given a group of points based on its degree of fullness. For example, in case of full stomach, it is given 20 points, in case of half full, it is given 10 points, and if is empty, it is given zero. The stomach contents are emptied in Petri dish, investigated, classified and the points which are given to the stomach are distributed to the food items. The points of each food item are calculated as percentage of the total points given to the stomach. This method had many criticisms. The importance of which is that the giving of points to the different food items is subjected to the author's opinion himself and it does not depend on weight or volume. Someone raise this method because of its speed , does not need tools or fixed measuring instruments, and is not affected by great numbers of small sized organisms.

Feeding habits

The action of feeding are carried out daily by most fishes, and may be the most frequent of voluntary activities. Flight from enemies, reproduction, migrations, and many other activities might be occasional or periodic, but feeding is usually part of the daily routine and in some species may require extended periods of time. Although many structures serve several functions in the life of the fish, feeding may be an important, if not the principal, use for them.

Closely related to the variety of food consumed by fishes is the function of the organs for seizing and assimilating the food. The buccal apparatus, which serves for seizing, chewing and swallowing the food, varies in

fishes. On this basis, fishes can be classified according to their feeding habit as predators, grazers, food strainers, food sucker and parasites.

An important factor in feeding is that some species find food by smell and taste and mainly night feeders, for example the family morymyridae which can feed both during the day and night. This is because they have poor sight and so they use electric organ situated on each side of the terminal portion of the tail, which serves as a Rader. Most predators feed largely by sight and are more active during the day light hours. Seasons influence water temperature in the non-tropical areas and water levels in the tropics seem to interfere with feeding in fishes. In the tropics, during the rainy season, the volume of water increases, reducing transparency and concentration of water, which reduces the primary production and all these, affect the feeding habits in fishes. Some fishes for example, the lungfish *protopeterus annectens* during the dry season live for months and accumulated fats. Other fishes find and select their food primarily by smell, taste for example *Gymnarchus niloticus*. Temperature also determines the rate of feeding, the higher the temperature, the higher the feeding rate and viceversa, although in the tropics, temperature does not usually alter the feeding rate of fishes as most tropical regions have stable temperature range. Distribution of food is equally important in which when the food materials are distributed in patches, the fish tends to move around in search of food, thereby reducing the feeding rate. The rate of consumption of food is also connected with the condition of the fish itself, many fishes cease to feed at their spawning time for example *O, niloticus* which is a mouth brooder.

Detection of possible food items at a distance can be through physical or chemical senses so that the eyes, the auditory organs, the lateral systems, or the electrical sense may serve to orient the fish toward

the food source. Some specimens are "sigh feeder" and approach food mainly on visual cues. In many species of fish the position of the eyes in the head serves the particular feeding habits. Surface feeder fish have the eyes oriented upward, whereas bottom feeders have the eyes on the lower part of the head looking downward.

The lateralis sense is of great importance in food detection in most fishes that feed on active prey. Even species that are strongly sight-oriented can continue to locate moving prey when forced to rely on the lateral line. The lateralis sense reaches a remarkable stage of development and great acuity in blind cave fishes and deep sea fishes. Nocturnal fishes and even some daytime predator such as some sharks depend heavily on the lateralis sense. Some fish have modified lateralis organs on the top of the head. Prey causing minute ripples at the surface can be detected easily.

Olfaction plays important roles in the feeding of fishes of all kinds. Many species that appear to feed mainly by sight are known to have acute olfaction. Bottom fishes such as eels have well developed olfactory systems. No doubt many species get the first signal that food is in the vicinity via the sense of smell.

Taste, along with the tactile sense, appears to be of great importance in final selection of food. The distribution of taste buds over the skin of a wide variety of species is well known. Such arrangement gives a broader area for the selection of food than if the taste receptors were only in the mouth or on the head. The greatest concentration of external taste buds is usually in the region of the mouth, on barbells, the snout and lips, where final selection is generally made. Not all materials taken into the mouth while feeding are swallowed. Many bottom-feeding species take various extraneous materials with their food and subject them to a selection process inside the mouth and pharynx. In many fishes

food appears to be separated from unwanted detritus at the level of the pharynx. Taste receptors are abundant on the gill arches, gill rackers, epibranchial organs and in the tissue surrounding the pharyngeal teeth. In many instances material is ejected through the gill openings after having been subjected to a final test by sensory facilities in the pharynx. Larger particle are usually ejected through the mouth with a" coughing" action. Gill rackers, pharyngeal teeth, and bristles, and epibranchial organs all serve mechanical functions in retaining or rejecting ingested material.

The amount of food ingested per day and the times of day that feeding is performed depend on many factors. Active predators, with their high metabolic rates, require more food energy than do sluggish fishes. Because metabolic rate varies with temperature, cold-water predators such as salmon should require less food than warm-water predators such as tunas. Studies on feeding of various fishes have shown that small individuals consume more per day in relation to their body weight than larger individuals.

The authors have been listed the major feeding types of teleosts as: predators, grazers, strainers, suckers and parasites.

1-Predators: Fishes that feed on macroscopic animals have certain adaptation in common. They have well developed grasping and holding teeth as in barracudas and the pikes (Esox). Predators have well defined stomach with strong acid secretion and the intestine is shorter than that of herbivorous of comparable size. Gill rackers are short, few and serve to protect the gill filaments from harm by the food.

Some predators actively hunt their preys such as blue fish, whereas other often lie in wait till an animal pass and then dart out to grasp it such as groupers. The dorsal fish of some bottom fish (e.g. angler fish) modified to lures for catching its preys. Some predator fish depend principally on sight therefore hunt their preys in daylight, while other fish hunt their

preys during night (e.g. morays) depending on olfaction, taste, tactile and lateral system.

2-Grazers : In grazing, the actual taking of food is by bites. Grazing habit characterizes many fishes that feed on plankton, hydrophytes or on bottom organisms. Examples of grazing fish are the blue gill fish which wander on the bottom grazing on benthic organisms. The parrot fish graze on coral reefs.

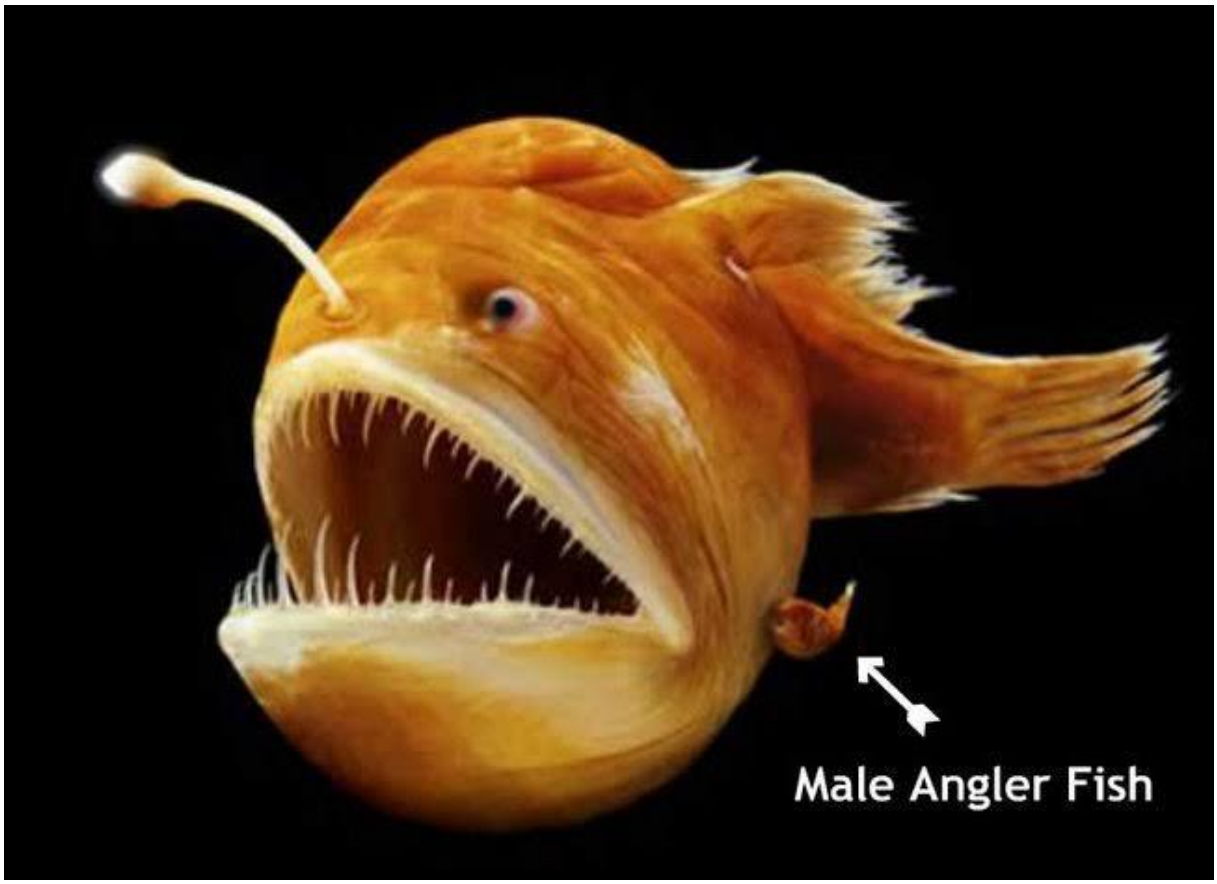
3-Strainer : Straining of organism from water is a generalized type of feeding as the food materials are selected by size and not by kind. Some fishes filter a great amount of water by their especially adapted gill rackers, which are numerous, fine and close-set. This device enable them to swallow large amount of food in short time e.g. menhaden, paddle fish, whale sharks and basking sharks.

4-Suckers: The fishes which feed by this method is usually bottom feeder such as sturgeon. These fishes are characterized by inferior protractile mouth, which is equipped with well-developed lips forming a sucker ideally suited for feeding on algae and detritus.

5-Parasites : Parasitism in the fish world is represented by the parasitic lamprey which absorb fluids and tissues of host fish after making a pore on body side by the help of his specialized mouth and tongue . The buccal cavity and tongue of lamprey are covered by horny teeth. The other example of parasitism among fishes is represented by males of angler fish which parasite on females of the same species. After hatching, male search for female, attached to her body by his mouth, the female develop a fleshy papilla by which the male can absorb the food material from the female. The male leave the free living at all, his size stay small in comparison with female, and he can be considered merely testis joined the female.

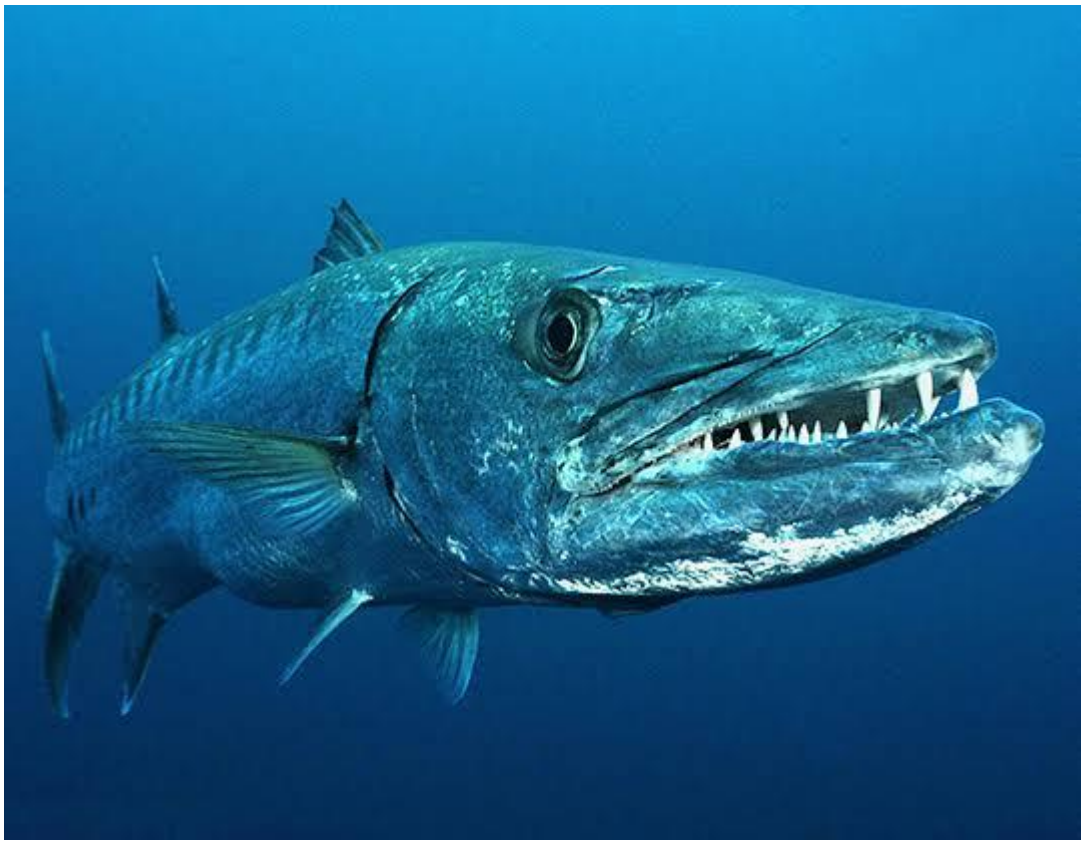
Paddle fish

Basking shark

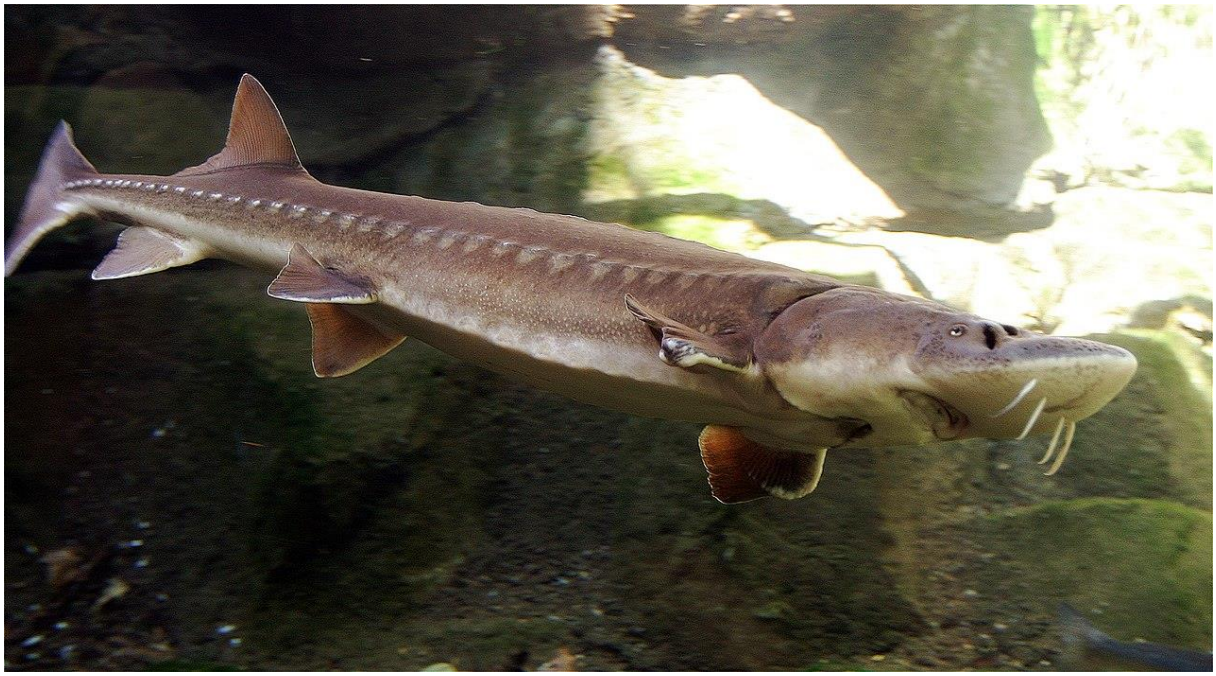


Angler fish

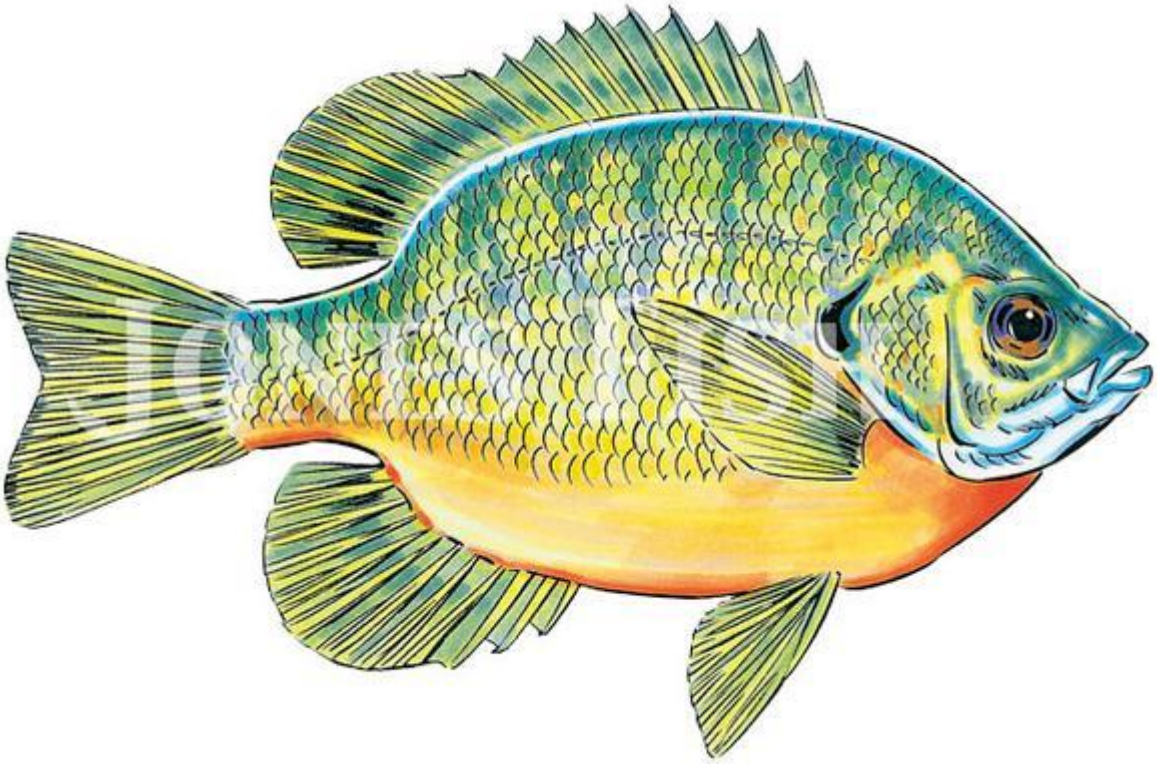
Parrot fish



Barracuda



Sturgeon



Blue gill fish