FIS 316: MARINE AND BRACKISH WATER ECONOMIC RESOURCES (2 UNITS)

Course outline

1. Study of major marine and brackish water fin and shell fish species in relation to their development for culture, food and industrial uses.
2. Methods of harvesting e.g. electro-fishing.

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Topic 1

Marine and Brackish water environments

What is Brackish Water

Brackish water is water which contains more sea salts than freshwater but less than the open sea. Moreover, brackish water environments are also fluctuating environments. The salinity is variable depending on the tide, the amount of freshwater entering from rivers or as rain, and the rate of evaporation. As a result many brackish water fishes are tolerant of changes in salinity, and in fact many positively benefit from similar periodic changes in aquaria.

Brackish water is water that has more salinity than fresh water, but not as much as seawater. It may result from mixing of seawater with fresh water, as in estuaries, or it may occur in brackish fossil aquifers. The word comes from the Middle Dutch root "brak," meaning "salty". Certain human activities can produce brackish water, in particular certain civil engineering projects such as dikes and the flooding of coastal marshland to produce brackish water pools for freshwater prawn farming. Brackish water is also the primary

waste product of the salinity gradient power process. Because brackish water is hostile to the growth of most terrestrial plant species, without appropriate management it is damaging to the environment

Brackish water normally naturally occurs in estuaries, deltas of rivers, lagoons and backwaters, which everywhere in the world are under tidal regime. In such habitats the salinity of the water fluctuates widely between negligible to 35 ppt, depending on the phase of the tide and volume of fresh water discharged through the river into the sea.

Technically, brackish water contains between 0.5 and 30 grams of salt per litre—more often expressed as 0.5 to 30 parts per thousand (ppt or ‰). Thus, *brackish* covers a range of salinity regimes and is not considered a precisely defined condition. It is characteristic of many brackish surface waters that their salinity can vary considerably over space and/or time.

The capacity of the residents of an estuary to tolerate a wide range of salinity that prevails there is by virtue of a dynamic physiological process of osmoregulation in which the gills, the kidneys, the skin and the buccal cavity lining play significant roles.

Water salinity based on dissolved salts in parts per thousand (ppt)			
Fresh water	**Brackish water**	**Saline water**	**Brine**
<0.5	**0.5–30**	**30–50**	**>50**

Brackish water habitats

Estuaries

Brackish water condition commonly occurs when fresh water meets sea water. In fact, the most extensive brackish water habitats worldwide are estuaries, where a river meets the sea.

River estuaries form important staging points during the migration of anadromous and catadromous fish species, such as salmon and eels, giving them time to form social groups and to adjust to the changes in salinity. Salmon are anadromous, meaning they live in the sea but ascend rivers to spawn; eels are catadromous, living in rivers and streams, but returning to the sea to breed. Besides the species that migrate through estuaries, there are many other fish that use them as "nursery grounds" for spawning or as places young fish can feed and grow before moving elsewhere. Estuaries are also commonly used as fishing grounds, and as places for fish farming or ranching

Mangroves

Another important brackish water habitat is the mangrove swamp or **mangal**.

Many, though not all, mangrove swamps fringe estuaries and lagoons where the salinity changes with each tide. Among the most specialised residents of mangrove forests are mudskippers, fish that forage for food on land, and archer fish, perch-like fish that "spit" at insects and other small animals living in the trees, knocking them into the water where they can be eaten. Like estuaries, mangrove swamps are extremely important breeding grounds for many fish, with species such as catfishes and some cichlids spawning or maturing among them. Besides fish, numerous other animals use mangroves, including such specialists as the saltwater crocodile and the crab-eating frog, *Fejervarya cancrivora* (formerly *Rana cancrivora*).

Brackish seas and lakes

Some seas and lakes are brackish. The Baltic Sea is a brackish sea adjoining the North Sea. Originally the confluence of two major river systems prior to the Pleistocene, since that it has been flooded by the North Sea but still receives so much freshwater from the adjacent lands that the water is brackish. Because the salt water coming in from the sea is denser

than freshwater, the water in the Baltic is stratified, with salt water at the bottom and freshwater at the top.

Fishes of Marine and Brackish water environments

The finfish and shellfish that inhabit brackish waters are invariably euryhaline i.e. they form a group of organisms which physiologically withstands wide changes in salinity of the surrounding medium. Stenohaline organisms are devoid of physiological mechanisms to tolerate wide changes of salinity. So, a special type of fauna inhabits the estuarine habitat beyond the sea-end of which live the stenohaline and saltwater forms. Examples of euryhaline fish are a mullet (*Mugil cephalus*) and mud-skipper, *Periophthalmus* and those of crustaceans are several species of penaeids (e.g. *Penaeus monodon*) and crab (e.g. *Scylla serrata*).

There are finfish and shellfish which spend different phases of their lives in sea, estuaries and freshwater streams. These forms transcend the salinity barrier by their osmoregulation. Such animals are either anadromous or katadromous. Anadromous fish, as exemplified by salmon or shad, are those that bread naturally in freshwater streams but spend the middle years of their lives in the sea. Katadromous forms, as exemplified by the eel, display the opposite kind of life cycle. These animals breed in the sea and spend the middle years of their lives in fresh water streams.

There are forms which restrict their migration between fresh water sections of the river and the estuary. Several species of palaeomonid prawns (*Macrobrachium rosenbergi; M. vollenhovenii*) are examples of shellfish which undergo such a life cycle. These forms breed in estuaries but spend the mid-years of their live in fresh waters. Then, there are forms which migrate back and forth between the estuary or a lagoon and the sea in different phases of their lives. A mullet (e.g. *Mugil cephalus*) or a shrimp (e.g. *Penaeus mododon, P. notialis*) are examples of finfish and shellfish which show such a pattern of migration. These forms breed in the sea but spend part of their juvenile and adult lives in the estuary where they form a sizeable fishery.

Fish Communities of Marine & Brackishwater in Nigeria

There is a definite pattern in the distribution of fishes on the Nigerian continental shelf. The original description of the distribution of demersal fishes by Longhurst (1965) is still valid. The available data indicate that the distribution of a number of species is limited by the depth of the thermocline and is influenced by the type of deposits (sand and silts) and the depths on the continental shelf, the slope of which is variable.

Though the broad distribution of the commercially exploited fish species groups is known, there is no adequate information on the composition of communities or on temporal and spatial distribution of stocks. In the circumstances of a very long coastline (about 800 km), it is almost certain that many species form more than one stock. The distribution of demersal and pelagic fishes in the marine waters of Nigeria indicates discrete ecological fish communities, each of which is fairly homogeneous. However, there is also ecological and micro-geographical heterogeneity of fish communities, whilst migration of species from the estuaries and creeks to the open shelf areas and vice versa is known to occur.

The following fish communities are exploited by the artisanal fishing units:

i. the estuarine and creek sciaenid sub community;
ii. the offshore suprathermocline sciaenid sub community (on soft deposits);
iii. the shallow suprathermocline sparid sub community (on sandy, corally and rocky substrates);
iv. the deep subthermocline sparid sub community (on both hard and soft deposits).

Estuarine and Creek (inshore) sciaenid sub-community

The fish community inhabiting the estuaries, creeks and other coastal brackish water consists of both freshwater and marine fish species. The estuarine sciaenidae (croakers) are dominated by *Pseudotolithus elongatus* whose bathymetric distribution extends to 20-m depth. But *P. senegalensis* and *P. typus* (which are a common element in the catch of the coastal open waters) also occur in the estuaries. The family Clupeidae constitutes an important element of the estuarine fish community. *Ethmalosa fimbriata* (bonga) and *Ilisha africana* (shad) are both caught in the shallow open waters and in the brackish water. Thirdly, the family polynemidae (threadfin) contributes significantly to estuarine and creek fisheries, but it is not yet possible to determine the exact magnitude of *Galeoides decadactylus, Polynemus quadrifilis* and *Pentanemus quinquarius*, which are harvested from brackish water. Additionally, other marine species in this sector include: *Pteroscion peli* (drum), which extends from the sea to the freshwater zone; *Lutjanus dentatus* (snapper); *Cynoglossus* (soles); *Pomadasys jubelini* (grunters); *Penaeus notialis* (Southern pink shrimp); the marine and estuarine *Parapenaeopsis atlantica* (Guinea shrimp); *Palaemon sp.* (white shrimp) and *Macrobrachium sp.* The other exploitable resources in the estuaries and creeks are: *Periophthalmus koelreuteri* (mudskipper), *Chrysichthys nigrodigitatus* (brackishwater catfish), *Arius spp.* (marine catfish), Trychurus lepturus (hairtail/silver fish), *Cybium tritor* (spanish mackerel), *Sardinella spp., Sphyraena spp.* (barracuda) and tilapiine species.

Clupeidae

Most clupeid species are marine but some are anadromous (shads) and *Ethmalosa fimbriata* (bonga) are adopted to withstand low salinities particularly in the rainy season.

a. Bonga (*Ethmalosa fimbriata*)

Bonga is the most important clupeid species in the coastal inshore waters of Nigeria. This species rarely goes below 20 m. It is more euryhaline than the flat sardinella and it is found in estuaries, the sea, lagoons and also in places that are liable to have great variations in salinity. It prefers warm and turbid waters. Because of these ecological preferences, it tends to replace the flat sardinella, and even more clearly the round sardinella, in those sectors without upwelling but with strong surface desalination. Its biology and migrations seem small in extent and limited to estuaries and the adjacent coastal areas (Longhurst, 1960).

Ethmalosa is a non-selective filter-feeder subsisting mainly on large diatoms and phytoplankton. The species migrates into and out of the estuaries following seasonal changes in salinity as well as with the abundance of plankton in the estuaries during the dry season. *Ethmalosa* tends to be more abundant in Nigerian estuaries during the period October-April. Its migration is possibly due to spawning and feeding.

Juveniles are definitely more abundant in rivers and in estuaries, while young spawners and adults can be found both in estuaries and at sea. This pelagic fish is a target species for the artisanal gillnet and beach seine fisheries.

b. Shad (*Ilisha africana*)

Shad is an anadromous clupeid inhabitinginshore waters, sand beaches and estuaries (in almost all fresh waters). *Ilisha africana* has a maximum length ($L\infty$) of about 22 cm and it has a good preference for crustacean and small fishes (juveniles).

It may be caught at the surface or near the bottom down to about 25 m. Hence it can be a target species for beach seine, gillnet, purse seine and inshore trawl fisheries.

c. Sardine (*Sardinella spp.*)

The flat sardinella is found from Mauritania to Angola. It is coastal fish, more euryhaline, most often found to be abundant near the outlet of water courses. It prefers warmer waters with a temperature above 24°C and seems to avoid waters that are not clear. It is not very abundant in areas without upwelling where the warm and low saline superficial layer is permanently present as in the Bight of Biafra and a large portion of the Nigerian shelf.

In Nigeria *Sardinella* spp. are caught by canoe fishermen using ring nets, cast nets, gillnets, beach seines and also by trawlers. But *Sardinella* is not a target species of any of the main fisheries.

Carangidae

The following carangid species are fairly abundant in Nigerian waters: They are (a) *Caranx* spp., (b) *Chloroscombrus chrysurus, (c) Decapterus rhonchus* and (d) *Trachurus* spp.

They are mostly schooling species distributed on the continental shelf but some occur in brackish waters especially when young.

a. Various jacks (*Caranx spp.*)

Caranx spp. has wide distribution along the West African coast from Senegal to Angola. Some species inhabit inshore waters and estuaries and the others are located in deeper waters (over 100–m depth). Hence, this fish group can be vulnerable to both artisanal and industrial fleets. *Caranx spp.* feed mainly on fish but also on shrimps, some crabs and invertebrates. This fish species group is caught in pelagic and bottom trawls, seines, set and ring gillnets and sometimes on line gear.

b. Atlantic pumber (*Chloroscombrus chrysurus)*

Chloroscombrus chrysurus occurs along the West African coast from Mauritania to Angola. This schooling pelagic species inhabits the Nigerian continental shelf at depths of 10–50 m. It also occurs in estuaries and the mangrove fringed lagoons and brackish water areas. Its juveniles are sometimes located offshore in association with jellyfish.

Atlantic bumper can be a target species of the artisanal fleet using set gillnets and seines as well as for the industrial fleets using trawls and operating in waters of 10–50 m depth.

c. False scad (*Caranx rhonchus)*

This is a schooling carangid species inhabiting near bottom waters, mostly between 30 m and 50 m but can be located in waters over 200 m depth. It feeds on small fish and invertebrates.

This species is mostly exploited by industrial fleets using trawls, but it can also be fished by artisanal motorized canoes using gillnets.

d. Horse mackerel (*Trachurus spp.*)

Horse mackerel occurs in schools in sandy bottom localities and usually at 100–200 m depth. Since the main fishing grounds are on the continental shelf, the species is not normally caught by artisanal fishermen. It is usually a target species of the offshore trawl and purse seine fisheries and sometimes it can be caught with longlines. It appears that the Nigerian industrial fisheries can exploit *Trachurus capensis* (Cape horse mackerel) and *Trachurus trecae* (Cunene horse mackerel).

Polynemidae

a. Lesser African threadfin (*Galeoides decadactylus*)

Galeoides decadactylus does not appear to penetrate below the thermocline. It occurs in inshore waters adjacent to sandy beaches. The species is known to develop female gonads by passage through a non-functional hermaphroditic stage arising from a normal male (Longhurst, 1965). Understanding its reproductive and recruitment strategy appear to be vital in the managing of this fish species.

Galeoides prefers silty and sand-silty bottoms. It is a semi-diadromous fish with spawning migration into estuaries and lower reaches of rivers.

Galeoides decadactylus feeds on benthic organisms such as crustacea and polychaetes. It is a target species for the artisanal fishery using gillnets and beach seines as well as the industrial fleets employing trawls in the inshore areas.

b. Royal threadfin (*Pentanemus quinquarius*)

Pentanemus quinquarius has a normal reproductive cycle. It occurs on sandy bottoms down to a depth of 50 m.

It is caught by the artisanal gillnet fishery on near-shore sandy bottoms but the species is also harvested offshore by the industrial fleet using trawls. In addition *Pentanemus* can be caught with beach seines.

c. Giant African threadfin (*Polydactylus quadrifilis*)

The giant African threadfin (*Polydactylus quadrifilis*) can grow up to lengths 150–200 cm. The species inhabits inshore and offshore sandy bottoms up to a depth of 50 m. It also occurs in estuaries and lagoons fringed by mangrove.

This fish species is jointly harvested by the artisanal fishermen and industrial fleets. Its attractive size has made it extremely vulnerable to gillnet and beach seine fisheries.

Sciaenidae

The croakers and drums are the important sciaenid species in Nigeria. This fish species group is primarily marine but also occurs seasonally in brackish water areas. Most of the species inhabit sandy and muddy bottoms in coastal areas with large river flows.

a. Bobo croaker (*Pseudotolithus (fonticulus) elongatus*)

   Pseudotolithus (fonticulus) elongatus prefers surroundings that are less saline. In fact, commercial concentrations correspond to the great estuaries in the gulf of guinea where the species can be caught in large quantities in certain seasons.

   They inhabit mud bottoms in coastal waters up to 50-m depth but also enter estuaries and coastal lagoons. This species, with maximum length of about 45 cm, moves further offshore to spawn during the rainy season. *P. elongatus* is jointly harvested by the artisanal and industrial fleets. It can be caught with bottom trawls, setnets, beach seines and longlines.

b. Longneck croaker (*Pseudotolithus (Pseudotolithus) typus)*

   Pseudotolithus (Pseudotolithus) typus) grows to a larger size than *P. elongatus*. It attains a maximum length ($L\infty$) of 100 cm and fish of 50-cm length are common in the catch. The main fishing ground for this species is from the Gulf of Guinea to the Congo. It is the most important commercial sciaenid species in Nigeria.

   Pseudotolithus (Pseudotolithus) typus inhabits mud and sandy bottoms up to a depth of 150 m but it is more abundant in waters of less than 60 m and temperature above 18°C. It also occurs in estuaries. Hence, it is fished by artisanal and industrial fleets using bottom trawls, bottom set-nets and long-lines.

c. Boe drum (*Pteroscion peli)*

Pteroscion peli occurs along the west coast of Africa, from Senegal to Angola. It inhabits mud and sandy-mud bottoms in coastal waters extending to 200-m depth. But it is most common in waters of less than 50-m depth.

This species is more accessible to the industrial fisheries using trawls and hook on line than to the artisanal fisheries using gillnets and beach seines.

Sparidae

The seabreams occur in fairly deep waters of the continental shelf and off the slope. The small young individuals do occur in shallow waters but mostly at a depth greater than 15 m, forming aggregations. The adult seabreams are more solitary. The most common species are *Dentex angolensis* and *Pagellus bellottii.* The seabreams are mainly exploited by industrial fleets in Nigeria. Many species are hermaphroditic (having both male and female gametes). Sometimes the majority of individuals are male at first maturity and the females appear later (protandric hermaphroditisms). In some cases the females are more at first maturity and the males appear later (protogynic hermaphroditism). Since protogynic hermaphroditism is associated with efficient utilization of good resources and parental care, it appears to be a better strategy for exploited sparid species.

a. Angola dentex (*Dentex angolensis*)

Dentex angolensis occur along the West African coast from Morocco 33°N to Angola. It inhabits various bottoms on the continental shelf and the slope from about 15 m to about 300-m depth. It is a protogynic hermaphrodite with most individuals beginning as females and changing to males at a length 18–23 cm.

Dentex angolensis is known to occur in Nigerian waters but the species is not an important element of the artisanal fisheries. It is caught by the trawl fishery but separate statistics are not available. Angola dentex is a carnivorous species feeding

on crustacea, small fish, molluscs and other invertebrates. It can be caught in bottom trawls, bottom setnets and longlines.

b. Red pandora (*Pagellus bellottii*)

The geographical distribution of *P. bellottii* extends from the straits of Gibraltar to Angola and also around the Canary Islands.

It is a protogynic hermaphrodite (the majority of individual are first females), then become males. Red pandora is omnivorous with a predominantly carnivorous diet consisting of crustacea, cephalopods, small fish and worms.

This is one of the most abundant sparid species in the CECAF area but it is not a target species of artisanal fisheries in Nigeria. It is possibly caught by the trawl fishery but separate catch data are not reported.