UNIT III

UNDERSTANDING FISH AND THEIR ENVIRONMENT

LESSON 18

FISH BIOLOGY

Return to Contents

LESSON 18

Fish Biology

Lesson Objectives

Following this lesson students will:

1. Be able to identify several freshwater, saltwater, catadromous and anadromous fish.
2. Be able to provide a definition of a fish and discuss its relationship to other vertebrates.
3. Understand basic fish anatomy and how the shape helps determine the specific life style of different species.
4. Be able to identify the fins of a fish and tell how they are used.
5. Understand why a fish has scales and body slime.
6. Know the importance of coloration and countershading.
7. Understand the purpose of gills and the gas (air) bladder.
8. Know how fish swim.

Materials for the Lesson

1. Overhead transparencies and photocopies of the salt and freshwater fish from the graphics.
2. Overhead transparencies and photocopies of the external and internal parts of a fish from the graphics.
3. Models or mounted fish that are popular in the local area.
4. Fish that have been caught in the local area and preserved by icing.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
I. Classification and Identification A. Definition of a fish	You may wish to involve a fisheries' biologist or the local high school science teacher in this lesson, especially if the students are older or more experienced anglers.
B. Relationship to other vertebrates	1. Introduce the class to the lesson objectives.
C. Identification 1. Freshwater fish 2. Saltwater fish	2. Ask the students for a definition of a fish. Depending on their age and experience, the answers will vary. They are cold-blooded vertebrates, with gills and fins, and live in an aquatic environment.
	3. Discuss the importance of the lesson to ultimate angling success. The better the angler understands the prey, the greater the chance of catching fish.
	4. Using the photocopied materials and the overhead transparencies, discuss saltwater, freshwater, anadromous and catadromous fish species. Discuss, compare, and contrast their shape and sizes and how these factors influence their particular life styles and their relationships with other vertebrates. If models or actual fish are available, show them to the students to assist them in the identification process.
II. Basic Fish Anatomy A. External B. Internal C. Skin 1. Scales 2. Slime 3. Colouration	5. Using the same instructional aids as above, discuss the various external and internal parts of a fish. Name the respective fins and discuss how they are used. Point out the scales (on certain species) and what they are for. Point out the gills and air bladder and state their particular functions.
D. Gills and Gas Bladder	6. Using models, real fish, or coloured pictures (if they are available), discuss the coloration of different fish, how they are counter-shaded, and why this is important.
III. How Fish Swim	7. Ask students how fish swim and how this differs from humans. 8. Discuss why these factors are important in fishing.

INTRODUCTION

Every angler should be able to visually identify locally popular sport and game fish. However, learning to name correctly the various species requires exposure and practice. Once a particular species has been seen a few times, it should be recognized instantly. Initially, an angler will learn to distinguish between basic differences in bass, catfish, and other species. Then the angler can concentrate on the lesser differences between bream and tarwine, or dusky and bartail flathead.

Successful anglers target their approach to specific species rather than merely putting a bait in the water and hoping something will strike. One needs to learn to identify fish, but a successful angler must know characteristics and preferences of the species.

Becoming versed in fish anatomy is more than an academic exercise. By looking at the form of a fish, its fin and tail structures and its colouration, one gains insight into its life style. The physical characteristics of a fish are adapted to the habitat in which it lives, and determines the food it will eat and how it will react. This is all part of the fish-catching process. When the angler knows the quarry, the results speak for themselves.

NARRATIVE

Classification and Identification

Definition of a Fish

Fossils show that fish inhabited the waters of the world more than 400 million years ago, but most of the more than 20-40 thousand living species had their origin in the last 100 million years. By definition, a fish is a cold-blooded, aquatic vertebrate (with a backbone) with permanent gills and fins (remember that the tail is considered a fin). A segmented, skeletal frame supports their bodies. Fish inhabit watery environments from the polar regions to the equator and can survive in depths of a few inches to as much as five miles or more beneath the surface of the sea, providing there is adequate oxygen.

Sport or Game Fish

Sport fish is the term used to describe any species caught for fun with a hook and line. Whether it is subsequently released or kept for food does not alter the definition. The meaning of game fish is not quite as clear. In one sense, it denotes a species that characteristically puts up a strong battle when hooked and brings a feeling of accomplishment to the angler. Virtually all game fish are predators and will take live prey. They can also be caught on artificial lures. When bass, barramundi, and mangrove jack are present, the eel or forked tail catfish probably would not be classified as a game fish by many Australian anglers. However, who can convince the youngster struggling to catch a fish that the trophy catfish he just landed is not a game fish! As a rule of thumb, consider that the top predators in any body of water are game fish. However, the International Game Fish Association, and the Australian National Sportfishing Association. recognize most fish species for record consideration.

Relation to Other Vertebrates - Food Predation

Along with mammals, birds, reptiles, and amphibians, fish are vertebrates. That means that they have a segmented backbone and a brain enclosed in a brain case or cranium. They are the only vertebrates capable of living underwater continuously without gleaning air from the atmosphere. Fish obtain oxygen that is dissolved in the water; the fish's gills extract the oxygen from the water.

Through the process of evolution each fish species has adapted to its environment. Although two species may look extremely similar and may be confused during the identification process, their life styles may have marked differences. Whether they graze on microscopic organisms or chase live prey, fish feed on something and, in turn, become food for another species. Nothing below the surface of the water is ever wasted or above predation.

Understanding the primary diet and how a species is positioned in the food chain become vital ingredients for the recreational angler. Furthermore, this information helps in selecting the proper bait. Fish are creatures of habit and exhibit certain behaviour patterns. They do not think as humans, but react to certain trigger mechanisms that signal food.

Identification of Common Sport Fish

Fish have two names, a common name and a scientific one. The well known publications such as “Grant’s Guide to Fishes” gives a list of official common and scientific names. However, it is not unusual for a fish to have several common names depending on the geographic location, but it can have only one scientific name. The Latin scientific name is in two parts, with the first representing the genus and the second the species. Genus is the main sub-division of a family of fish and is made up of a small group of closely related species. It is capitalized. The second word refers to only one species and is not capitalised.

The painted sweetlip *(Diagramma labiosum)*, a member of the sweetlips family (HAEMULIDAE), is known by a variety of names that include slatey bream, blackall, mother in-law fish, and moke. The sweetlip emperor *(Lethrinus miniatus)* belongs to the emperor family (LETHRINIDAE) and the red emperor *(Lutjanus sabae)* belongs in the seaperch or snapper family (LUTJANIDAE), while the snapper *(Pagrus auratus)* belongs to the sea bream family (SPARIDAE). There is never any confusion with the scientific name, which refers to a single species. That becomes the final identifying test.

Common names can sometimes deceive the angler who, in learning to identify fish species, often gravitates naturally to the accepted common names in a particular geographic area. It is important to know these because other fishermen will be using them. However, it is equally valuable to be familiar with other common names and to recognize that the scientific name removes all doubt.

Identification Methods

Most fishermen learn to identify fish by sight and to rely on certain distinguishing characteristics to separate species. Scientists are much more precise in their methods of identification. An angler can afford to be wrong on occasions, but a researcher cannot. In some cases, one must count the fin rays, which are the bony rods extending into the fins. They can be spiny (hard) or soft rayed. Another method is to count scales along the lateral line. As a fish gets bigger, the scales increase in size, but the number stays the same.

There are three ways to measure a fish. Standard length starts at the tip of the snout (mouth closed) and extends to the base of the caudal fin (tail). The fork length starts at the front of the mouth and goes to the tip of the shortest ray of the caudal fin. Finally, total length extends from the mouth to a perpendicular line drawn to the extreme tip of the caudal fin. The depth of the body is measured from the back to the belly at the deepest part. Girth is the measurement around the fish at this point. Counting gill rakers or fins in the field is a tedious method and not recommended except where identification is critical. For the angler, experience and practice are still the best ways to achieve identification skills.

Freshwater Fish

The ability to identify the fish one sees or catches adds an exciting dimension to angling. With a little practice, almost anyone can achieve this skill. Start with the more common sport fish families in the immediate area. There are similarities among members of the same family as well as differences, and these may prove important in the identification process.

Shape, coloration, fins, mouth, eyes, skin (scaled or smooth), and the presence or absence of certain features often become keys to naming a fish correctly. One should also consider the type of water from which the fish was caught or in which it was seen. Water temperature might also provide a clue since certain species favour colder waters than others.

Among the more common and popular families of fresh water fish, one finds the golden perch (yellowbelly), silver perch, Australian bass, and murray cod and eel tailed catfish.

Saltwater Fish

Marine species are first characterised by their skeletal structure into cartilaginous or bony fishes. Sharks**,** rays, and skates use cartilage as the basis for skeletal support, while most other species fall under the category of bony fish. Several of the bony fish are relatively easy to identify simply by looking at them.

Sharks, Rays, and Skates

There are over 300 species of shark. Sharks range in size from the tiny dwarf shark 25cm long, to the 14 metre long whale shark. Fewer than half of all shark species grow longer than 1 metre in length and only 30 species are known to be dangerous to people. Some such as the hammerhead and great white are easy to identify. Others require considerable experience. However, sharks and rays are seldom mistaken for any other type of fish. The problem lies in determining the precise species of shark. One may be able to point out differences in photographs of various species, but in water, identification is more difficult.

Skates and rays are flat and have cartilaginous skeletons. There are a number of species of both. Skates do not have a poisonous barb near the base of the tail or on it; rays do. A tendency exists to lump all rays together under that common name, but each species has its own name. The shovel nosed ray, incorrectly called shovel nosed shark, is the most commonly caught by anglers in Queensland. It has no dangerous features. The eagle ray, blue spotted ray and the stingaree all have spines at the base of their tail whereas the bull ray, rat tailed ray and manta ray do not have spines.

Bill fish

Billfish is the generic name given to a group of large game fish that prowl the warm and temperate waters of the Queensland coast. They all have long, pointed upper jaws that form a "spear" or "sword" and include the marlins, sailfish and swordfish.

If the colouration is ignored, bill fish are relatively simple to tell apart. The sailfish has a massive dorsal fin that is taller than the deepest part of its body. Blue, striped and black marlin have pointed dorsal fins, but there are other differences. The pectoral fins on a black marlin are rigid and do not fold back as they do on the blue and striped marlin. The pointed front of the dorsal on the striped marlin is higher than that of the blue, but the blue has a much higher anal fin than the striped. The swordfish has a very long wide bill, plus a high curved dorsal fin.

Flounders

Flounders form a group of salt water fish known as flatfish. They live on the sandy or muddy bottoms of bays and along our coastal shoreline. They ambush their prey by hiding on the bottom. For camouflage, on their upper side they have a dark, mottled colouration, which may vary according to the sea bottom, while the underside is white or creamy in colour. These fish even swim on their side. Some have both eyes on the left side, while others have them on the right. Recognizing members of the flounder families doesn't take much skill, but there are several species among both the left eyed and right eyed flounders. Those families are named according to the side of the head on which the eyes appear. The two common species are the large toothed and small toothed flounder. Another common flatfish to our coast is the sole, probably named because of its comparison to the shape and thickness of a sole on a shoe.

Other Species

Oceans and estuaries contain many families of fish. Snapper, mangrove jack, tuna, and mackerel, along with many bottom dwellers, require experience on the part of the angler before identification of the specific species becomes routine. One might recognize the family, but the particular species takes more time. Cod family members all have a similar body shape, being rounded and stocky, but the variation in colours is the significant element for identifying the many types found along our Great Barrier Reef and estuaries. Such names as; tomato, purple, potato, barramundi, flowery, maori, gold spot, refer to the colour or pattern on the skin.

The key lies in learning those species first that are more common and abundant in local bays and coastal waters and then adding to that knowledge as fishing trips take one farther afield.

Anadromous Fish

By definition, anadromous fish move from salt water and ascend fresh water rivers to spawn. Mangrove jack are found in estuaries and coral reefs. They move into the tidal influences of coastal rivers to spawn and remain as a juvenile until they reach a length of approximately 35cm. At this stage they are mature and move to become a resident in a coral reef, until such time as they move into the estuaries to spawn.

Basic Fish Anatomy - External Body

The shape of a fish’s body is a visual clue to the life style of that species. A queenfish that spends most of its life moving around chasing baitfish is more streamlined than a grouper which lives in a cave close to the sea bottom and feeds by ambush. A closer inspection reveals that the queenfish body is sleek and torpedo shaped so that flowing water will pass around it with a minimum of friction. Grouper have broad flat tails and a stocky body, which makes them highly manoeuvrable. They are adapted to swim around coral and structures to take advantage of whatever cover they can find. The most efficient design for speed through the water is the fusiform shape in which the greatest body girth is about one third of the distance from the nose to the tail. Tuna are a prime example of this.

Fins

A fish's dorsal fin extends vertically from the back, usually starting rearward of the gill cover or operculum. Some are spiny rayed, meaning that they have hard, bony projections separated by membrane. Others are softrayed, in which the supports are supple and not hard. Fish may have one, two, or three dorsal fins. They could be a combination of spiny and soft and they may or may not be connected. Two of Queensland’s common fish having two dorsal fins are the king threadfin salmon and blue threadfin salmon.

The dorsal fin, along with the anal or ventral fin located just behind the anus, aids fish in maintaining balance and, in some species, help them manoeuvre in tight places. Pectoral fins (one on each side) are positioned right behind the gill covers and are a modification of arms. They are used for staying in one place and for fine tuning a fish's position. On fast moving species, pectoral fins serve as bow planes, helping the fish to dive or surface.

Pelvic fins correspond to animal legs and sometimes have special functions such as holding, grasping, or even crawling. On most fish, they aid in positioning and balance. Species that move with extremely fast speed often are able to pull the pectoral and pelvic fins tightly against the body or into shallow recesses. It is important to note that all species do not have all fins, but most sport and game fish do have dorsal, ventral, pectoral, pelvic, and caudal fins.

The caudal fin, or tail, tells a great deal about the speed and manoeuvrability of a fish. Any species with a forked tail is a fast swimmer. Forked tails are hard on the outer edges like a skindiver's flipper and soft and flexible on the inside. Broad flat tails indicate the ability to turn quickly and to start swimming instantly. Bass fall into this category.

Scales

A fish's body is covered with scales (in most species) that serve as protective plating to prevent abrasions or skin diseases. The number of scales on a given fish remains constant and does not change as the animal gets larger. Like the cross-section of a tree trunk, scales show rings for growth and are a tool for scientists trying to determine the age of a fish.

Scales are really modified skin cells and take various shapes. Those on sharks are actually tiny teeth called dentils and are extremely abrasive. The tarpon has massive scales, often much larger than a silver dollar. Some of the fastest swimming fish, such as the tuna, trout, salmon, mackerel, and others, have very tiny scales.

Slime

Slime coats the body of a fish, serving as protection against disease, fungi, and parasites. It also aids in reducing friction and may have benefit in reducing the transfer of water through the body wall. In handling a fish prior to its release, extreme care must be taken to minimize the damage to this slime.

Coloration

Coloration means the disposition of colours. Coloration in fish serves a variety of purposes from concealment and camouflage to recognition by schoolmates. Every hue imaginable appears in one species or another and some have the ability to change colour. When fish get excited, a colour change often occurs with portions of the shading becoming much more vivid and neon in appearance. Taxidermists frequently paint dark purple markings on the side of a marlin. When it is caught, the coloration becomes much more vivid than normal because the fish was stressed.

Almost every species is countershaded or dark across the back and light on the belly. It is an effective form of camouflage that makes a fish look flat, eliminates dimension, and compensates for light coming from all directions. When a predator looks down on the dark back, the fish is difficult to detect. Viewed from below, the light belly blends with sky and clouds.

Fish are marked in a variety of ways to complement their life styles. Bottom dwellers are usually mottled, while pelagic species are silvery or relatively light along the flanks. Species that are all silver on the flanks reflect their surroundings and gain camouflage that way. The pattern of a murray cod resembles sunlight filtering through an overhanging tree. By definition, stripes on a fish run horizontally and bars and bands completely encircling the body are vertical.

It is important to realize that the reds are the first colours to disappear with depth or horizontal distance in water. Red colours may look bright to the angler on the surface, but quickly fade underwater. Blues and greens retain their colour to the greatest depth and distance.

Bright colours on a fish are vital in schooling behaviour, for spawning, and also in establishing territories. Other members of the same family can see the colours of a fish in residence and keep out.

Skeleton

Most fish have a bony skeleton with the various body parts held together, and to the skeleton, by connective tissue. Sharks, of course, have a cartilaginous skeleton. These are extremely complex structures. The organs of sense along with the brain are held in the skull. Since fish are vertebrates, there is a backbone running the length of the animal. The position and structure of the spine aids some species in swimming, offering the flexibility necessary to undulate from side to side. Bones attached to this serve as ribs. The skeletal form determines the shape of the fish, protects the vital organs, and serves as support for the muscles.

Gills

A fish's cells, as with all animals, require a continuous supply of oxygen. The exact amount depends on water temperature, level of metabolic activity, and the particular species. The gleaning of oxygen and release of the by-product carbon dioxide occurs through the gills. Bony fish have four pairs of gills, while sharks may have as many as seven. Fine, red filaments in the gills aid in the interchange.

Water enters through the mouth, which then closes. The operculum, or gill covers, opens slightly and water passes through, moving over the filaments. In moving water or when a fish swims, the flow occurs without aid. With a stationary fish or when there is no water flow, the flow of water is created by opening and closing the mouth.

Soluble pollutants can affect fish as water is passed through the gills. Fish absorb toxins through the gills as well as through the food chain. Also, sediment can serve as an irritation, causing inflammation or actually clogging gills, and making it difficult for the fish to receive adequate oxygen.

Gas Bladder

If it wasn't for the gas or swim bladder, many species of fish would have difficulty hovering in the water because they are heavier than water and would sink. In most fish, the gas bladder is an air tight sac (closed system) much like the human lung. Fish can inflate or deflate it at will. Some primitive fish have an open system with a tube leading into the oesophagus, allowing them to gulp air. Position of the swim bladder is vital and it is usually found near the fish's centre of gravity. If the bladder were too far forward, the fish would tip upward.

Swim bladders are larger in freshwater species, occupying 7% to 11% of body volume. Because salt water is more buoyant than freshwater, saltwater species have a bladder occupying 4% to 6% of body volume. Some species do not have gas bladders or do not rely on them. Tuna, shark, mackerel, and others remain in motion to force water across the gills and do not need a bladder. If a fish were to rise too rapidly, the bladder would expand and the fish could not get back down until the air was eliminated and the bladder reduced in size.

How Fish Swim

Most fish swim by undulating their bodies in a wavy motion and snapping their tails. Forward thrust comes from the backward push of the muscle wave,

culminating in the tail snap. Fish are almost solid muscle arranged in segments or flakes. These muscles are controlled separately so that a wave or rippling effect can be created. If a segment on the right is in full expansion, the opposing muscle on the left side is in contraction. Thinner and longer fish use more of the wave motion to swim. Species such as coral trout and the cod species depend on their broad tails to propel them. Members of the tuna family generate incredible speed by beating the tail as much as 10 to 20 times per second. A single tail beat drives the tuna about a body length.

In general, the larger the fish, the faster it can swim. There are variations among species, but one can estimate that the top speed of a fish is about 5 kilometres per hour per 300mm of their length. Swimming speeds are also calculated as sustained and burst. Burst speed covers a sprint over a very short distance. When fish of the same size school together, their swimming efficiency is enhanced. Larger fish swim faster and smaller ones have to exert more energy to keep up with the school.

As a fish swims, water passes through the mouth, over the gills, and out behind the gill covers. This water moves along the body of the fish, reducing turbulence and creating a laminar (smooth) flow that lessens the drag. Research has shown that most species open the gill covers to achieve maximum laminar flow. Some species even excrete a special slime that reduces body friction when swimming. A few species rely on their fins for propulsion, but that is not a very effective method. These are bottom, reef or weed bed dwellers that work in and out of cover. Most fish use their fins for positioning and for very gentle movement, but it is the muscular undulations followed by tail snaps that constitute the swimming action.

LESSON 19

FISH BEHAVIOUR

Return to Contents

LESSON 19

Fish Behaviour

Lesson Objectives

Following this lesson students will:

1. Understand why fish act and behave the way they do.

2. Be able to discuss the reaction of different species to food, comfort zones, reproduction, predator/prey relationships, and seasons.

3. Understand the influence of biological necessities such as spawning, seasonal migrations, food consumption, and seasonal adjustments.

4. Be able to discuss how an angler can benefit from this knowledge.

Materials for the Lesson

1. Overhead transparencies and photocopies of graphics in the appendix.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
I. Reasons for Behaviour	1. Introduce class to the lesson objectives.

A. Evolution
B. Anatomy
C. Habitat
   1. Structure
   2. Thermocline
D. Senses
II. Types of Behaviour
A. Food
   1. Location
   2. Protection
B. Comfort
   1. Oxygen
   2. Temperature
C. Reproduction
D. Predator/Prey
E. Seasons
	2. Begin the class by discussing factors which affect fish behaviour.
	A. Water Temperature
	B. Anatomy
	C. Spawning
	D. Food preferences
	E. Predator/Prey Relationship
	F. Seasons
	G. Structure
	H. Oxygen
	I. pH Levels

III. Learning about Fish A. Migration B. Food Consumption C. Spawning D. Adjusting to Seasons	3. Select graphics for several locally popular species of fish. Discuss each of the above factors for each species that you choose. The text has much information that will be of assistance. 4. Use graphics to show where the angler can expect fish to be found during different seasons of the year, and how the food chain affects them 5. Throughout the class discussion, relate these factors to angling success.

INTRODUCTION

Understanding fish behaviour is both important and interesting. By understanding fish behaviour, one gains a greater appreciation of fish and their delicate place and important role in nature and in the total biology of waterways. Anglers gain an insight into how and why fish react, where they most likely live, and why each species has different food requirements and prefers different habitat. This understanding translates into knowing where and how to fish, what lures to use, locations of fish at different times of the year, predator/prey relationships, and the role of senses in catching fish.

NARRATIVE

Reasons for Behaviour

Behaviour is nothing more than the way an animal reacts and the causes of that reaction. All animals exhibit behaviour unique to their species and environment, and fish are no different from other animals. Basic to this behaviour is the role of evolution. This reaction to the environment affects the selection of water temperature sought by fish, their oxygen requirements, basic anatomy, spawning methods, food sought and eaten, position in predator/prey food chain structure, and seasonal movements and migrations.

The basic anatomy of the fish controls what it does, how it moves, and what it eats. The long body of wahoo, mackerel and barracuda makes them extremely effective in tracking prey (or lures) but less able to turn rapidly (as would a bream, bass, trevally, or catfish) to take a lure or to grab a baitfish.

Anatomy also controls the speed of the fish. Marlin, sharks and king threadfin salmon are known as fast swimmers since their body muscles control wide tails. The same applies to the football-shaped tuna and albacore. Barramundi, mangrove jack and mulloway are not swift swimmers but are powerful and turn quickly. The shape and position of the mouth in whiting, bonefish, carp, catfish and threadfin make them ideal bottom feeders, while the teeth of mackerel, tailor, barracuda, wahoo, and mulloway make them ideal for catching and holding slippery, fast-moving baitfish. As a result, bottom feeders are often constantly moving, while some predators such as mangrove jack will lurk by a structure and wait to ambush passing food.

Structure in habitat is also important, although some fish do not relate to structure and constantly swim, searching for food and working to maintain favourable oxygen, temperature, light intensity, current and comfort zones. Many ocean fish, such as wahoo, billfish, shark, bluefish, tuna, dolphin and salmon, are free swimmers. Some inshore saltwater species, such as tailor, mulloway, bream, and others, stay near structure areas, e.g., sand bars, rocky bottoms, and oyster bars.

Many freshwater species, including Australian bass, yellowbelly, murray cod, sooty grunter, and saratoga hold in a position next to a structure or cover in the water and cannot survive well in waters lacking this required structure. In the freshwater environment, the Australian bass follows the oxygen or temperature levels as they search for food. Many ocean species of fish also feed in a similar pattern.

Senses are far more acute in some fish than in others. These are significant in their feeding behaviour. Eels and salmon are noted for their ability to smell. Bonefish and threadfin feed by taste, and catfish have taste buds all over their bodies so that they can taste a food before even taking it into their mouths. Sight and sound feeders include bass, billfish, barracuda, shark (though they also feed by smell), tuna, mulloway, mangrove jack and barramundi.

Types of Behaviour

Food, water temperature, oxygen, pH, current, reproduction, predator/prey relationship and seasons all affect what fish do, how they do it, where they do it, and when. Fish must have food on a regular basis. While each species varies in its food requirements, the presence and ready availability of food is mandatory for preservation of a species. Some fish hide and wait for food. Others actively and constantly hunt forage fish. Some constantly search the bottom for food, almost like grazing cattle. Ideal food situations for different fish species can include everything from the presence of large schools of bait fish, to a fertile bottom, to structure that will hold and allow for reproduction of a basic food chain, some of which will be food for the fish.

Oxygen requirements are critical but will vary with the species. Carp, catfish, and lungfish require relatively small amounts of oxygen in the water, while barramundi and salmon require a lot. Thus, bass can be found in highly oxygenated, free flowing streams, but may not be found in depleted habitat where carp can still thrive. Bass thrive best in water containing up to 10 parts per million of oxygen while carp can survive on as little as 2 or 3 parts per million of oxygen.

Temperature is also important. "Tropical species", including the barramundi and threadfin salmon, require warmer water than "sub-tropical species", such as bass and tailor. These cooler temperatures would kill any of the tropical species. Even different species of the same families differ. Northern saratoga *Scleropages jardini* require the warmest water of the popular stocked saratoga species. The southern saratoga *Scleropages leichardti* may be able to tolerate colder temperatures and more silting and are more suited to the south of the state.

All fish, as a result of their cold-blooded nature, become more sluggish in colder water and require less oxygen and food. Their metabolism slows considerably, thus reducing their needs.

Fish have pH (hydrogen ion content) requirements, but most fish can tolerate a range of 3-4 pH units i.e. between 6.5 and 8.5. This is of great importance today because of the great concern about acid rain and the adverse effect that this has had on our lakes and streams, primarily in the dams. pH is a balance of hydrogen ion content of the liquid (water in this case) with a pH of 7.0 being neutral. pH numbers range from a low of 0.0 (acidic) to a high of 14.0 (alkaline). Numbers greater than 7.0 are alkaline (high pH) while smaller numbers (less than 7.0) are low pH and acidic. The lower the number the more acidic. The numbers are based on a logarithmic or geometric ratio, not an arithmetical one. Thus, a variation of just one point in the pH (1.0) can markedly change the acidity, and significantly affect fish behaviour and comfort. High acidic (below pH 5), or alkaline (above pH 9) waters can markedly reduce fish populations, kill fish, prevent reproduction, destroy eggs and fry, and make any fishing or enjoyment of a waterway impossible.

Current may or may not affect fish. Fish that require current, such as jungle perch, do not generally do well in waters with no current. However, when young fry or fingerlings of a species are present, too fast a current (as during a spring flood, hard rain, water released from a dam) will wash them downstream and destroy that season's production. Fish react in different ways to current. Some fish hide or rest by a rock or other structure to stay in the buffer zone that surrounds all obstructions.

Other fish will actively seek a current and follow it for the information (smell, taste, and temperature) that it provides. In all cases, fish will head into a current. To do otherwise would wash water backward through their gills, which would make them uncomfortable or kill them. This is why in eddies or currents, in which the current turns back upstream, fish will be facing downstream but headed into the eddy current.

Reproduction plays a most significant role in the behaviour of fish. It is the reason for bream coming into the estuaries in the winter to lay eggs. It is also the reason that eels make long runs down rivers to spawn in the Coral Sea (catadromous). Some species, such as bass and jungle perch, make similar short runs down rivers or tributary streams to spawn in tidal brackish water. Salmon in America and Europe make long runs from the ocean to the headwaters of free-flowing, fast current rivers to lay eggs in the same waters where they were hatched (anadromous).

All fish have a role in the complex predator/prey relationship. Usually the prey species are small, very numerous, and travel in schools. Prey species are somewhere in the middle of the food chain, eating smaller organisms such as insects, smaller fish, invertebrates, and crustaceans, while providing food for those fish at the top of the food chain, primarily the "gamefish" or sport species.

In a general sense, fish reaction depends upon whether they are predator or prey. Small prey species move and react as hunted species. Large predator fish at the top of the food chain have less to fear from most other fish species. As a result, they are calmer, less "nervous" in the water, and move more slowly, except when actively chasing prey, attacking a food species or feeding on schooled baitfish.

Seasonal patterns determine the water depth sought, food intake, migration patterns, spawning, coastal movements, schooling and general activity of fish. Seasonal changes are accompanied by changes in water temperature, the amount of light, and hours of daylight. Summer months have more light and longer hours of sunlight than winter periods due to the higher angle of the sun.

Lower temperatures result in less fish activity, often semi-hibernation at deeper depths, schooling with some species, and reduced food intake. Warming temperatures and a higher sun angle in the spring usually trigger spawning behaviour, voracious feeding and a return to shallower waters. Seasonal patterns are a continuous cycle in which a given species can be counted on to perform similarly during the same season year after year.

Anglers use this information, even if they are not always aware of it. Tailor and sea mullet travelling up along the Queensland coastline in the colder months, which is known as the annual run, is an example of using seasonal patterns and information to catch these fish. Summertime saratoga hold on breaklines near shallow water or near wood structure, while bass and yellowbelly species follow the sharp temperature gradient, called a thermocline during the same months.

Learning about Fish Behaviour

Good anglers must learn about fish migration. Migrations vary with each species and most fish have some migration or movement on a daily basis. These include movements from shallow to deep or deep to shallow water, movements into feeding areas, and movement varying with light intensity or water temperature. During the warmer months, many species frequent the shallows to search for food. Often as light intensity increases, they move out of the unprotected shallows (where they could become prey for birds of prey or shoreline animals) and migrate to protected deeper waters. Even if not searching for food in the shallows, many species are sensitive to light and move to deeper waters. Migrations also include horizontal movement, movement from a shallow cove out into a channel or breakline in deeper water.

Salt water species are also subject to daily movements based on tides and currents resulting from tidal flows. These movements are not based on sunlight intensity or a temperature gradient (although these can also be factors), but on the flow of the water with the resulting current and the movement of their prey. These daily up and down movements, small migration routes based on tidal flow or food supply, are found in some degree with all species. Seasonal migrations are also caused by broad changes in food availability, temperature, current changes, light intensity and spawning urges. Seasonally, fish make major changes in their behaviour. Winter often finds warmer water fish such as mangrove jack in Southern Queensland, in a dormant or semidormant state and schooled together seeking the warmer deeper holes. Offshore salt-water species usually go north, following specific warmer coastal currents.

Spring finds most species spawning and moving to waters, or areas where spawning is possible. It is also a time when fish become active feeders since they require more food as their metabolism rises with the rising temperatures. Summer is a time for adult fish to recover from the rigours of spawning (which for some species can be extremely strenuous) and to follow regularly established feeding patterns, often with shallow and deep daily migration patterns due to the changing light intensity. Food consumption varies with the size of the fish, species of fish, food habits of the fish and season of the year. Food consumption definitely affects the behaviour of any fish species since adequate food is paramount to continued life. Just how and what a fish eats will affect its movement, schooling habits, and presence at different water depths.

Some fish feed by constantly searching the bottom (threadfin and catfish), some actively feed from the surface (bass and saratoga), and others only eat at the mid depths. Some will pick up any type of dead bait (bream) while others insist on live bait or a lure that resembles live bait (marlin and sailfish).

Spawning is an ideal time to catch fish, although with some species it is also a controversial time. Some anglers and biologists feel that too many fish can be taken too easily during this period, which could contribute to the long term detriment of population stocks. This depends greatly upon the species. Some species such as the pacific coast salmon in America die after spawning so that catching these fish during their spawning period or immediately after will not affect the long term survival of the species.

Wild stock yellowbelly, silver perch and murray cod, need a river flood and a rise in water temperature to spawn. Bass, jungle perch and barramumdi all need to swim downstream to reach the saltwater to spawn. These fish species have to be introduced as fingerlings, from a restocking program, as they do not breed in dams, impoundments and lakes. Spotted mackerel and tailor are popular east coast fish that make long spawning runs and do not die after spawning. They can be taken in large numbers in their spawning areas which is affecting the fishery over a large area.

Spawning methods vary greatly and occur from holding the eggs in the mouth like saratoga to guarding them in hollow logs like Mary River cod. Sooty grunter spawn on brush, plants, or bottom structures while yellowbelly and murray cod use the current in a flood to spread their eggs far and wide. Fish like bream, tailor, and ocean species are free spawning. The eggs are fertilised and distributed to the open waters.

Different seasons find fish in different places and exhibiting different behaviour. Anglers must adjust to these variations to catch fish consistently. This takes knowledge of the fish and an understanding of the way they act and react. Food preferences, water types, spawning patterns, thermal requirements, structure needs, salinity limits, and other environmental preferences must be understood for each species of fish sought.

LESSON 20

FISH REPRODUCTION AND GROWTH

Return to Contents

LESSON 20

Fish Reproduction and Growth

Lesson Objectives

Following this lesson students will:

1. Understand how spawning affects a fish's behaviour and governs movements and migrations.

2. Be able to identify changes in behaviour as well as physical differences and follow the spawning cycle

3. Know the importance of spawning cycles and seasons as they relate to fishing.

4. Comprehend basic relationships between predator and prey.

5. Understand the relationship between age and growth.

6. Identify the factors affecting fish growth.

7. Learn why each species has its own foods and how this food helps to determine growth.

8. Know the feeding habits of various species and how these habits relate to fishing.

Materials for the Lesson

1. Overhead transparencies and photocopies of appropriate graphics from the appendix.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
	Due to the content of this lesson you may want to invite a fisheries' biologist to participate and discuss many of the scientific aspects of this subject. He/she may also be able to bring a film or film strip to illustrate much of the content.
I. Reproduction A. Spawning Cycles as Behaviour Regulators	1. Introduce students to the lesson objectives.
B. Breeding 1. Behaviour 2. Care of Young C. Sexual Differences 1. Coloration	2. Begin by emphasising that the biological urge to spawn overrides other behaviour patterns. Discuss the spawning of several locally popular fish. Indicate the type of conditions needed by these fish, that they all, even those of the same species, have a preferred time and a preferred habitat for spawning.
2. Size 3. Morphological Changes	3. Discuss the spawning behaviour of fish that may not be favourites in your area. Barramundi, jungle perch, and bass move down streams to spawn. Other fish do not spawn every year, and the number of eggs deposited varies greatly with the species.
	4. Discuss how the eggs are fertilised, hatched, and protected.
II. Foods, Digestion, Nutrition and Growth A. Fish and the Food Network 1. Predator/prey 2. Food Preferences	5. Discuss the predator/prey relationship and its effect on growth. Predators will prey on almost anything smaller, including its own species. Lack of baitfish or an over-supply of predators can limit or stunt growth and lead to a smaller number of larger fish.
B. Food Conversion	6. Fish convert food to energy slowly and this varies with many factors. With cold water, fish require less food and it is digested more slowly. Fish seem to prefer certain foods, such as crayfish in freshwater and prawns in saltwater, if they are available
C. Fish Growth 1. Factors a. environmental b. water quality c. age	7. Discuss fish growth and the factors that influence growth including: A. The abundance of food, B. Water temperature, C. The type of habitat or body of water, D. Carrying capacity - each body of water can adequately support a certain number of fish, E. The amount of space required by certain species, F. Water turbidity and its effect on spawning and photosynthesis.
	8. Discuss growth rates since fish initially grow quite rapidly while young, but much more slowly when older.

D. Fish Feeding Habits

9. Ask students what they know about feeding habits of locally popular fish. Indicate that many species of fish feed close to where they were born, while others roam great distances, following migrations of baitfish and temperature gradients in larger bodies of water.

10. Discuss the methods that locally popular species utilise to feed. Discuss the shape of the fish's body and how this affects their feeding behaviour. Discuss how these methods can vary from still to flowing waters.

11. Ask students how the information presented relates to fishing success. Angling success can be greatly increased through understanding the concepts presented in this lesson.

INTRODUCTION

To the angler, spawning is more than a process for reproducing the species. Usually, there is a movement or migration associated with spawning as well as with changes in behaviour. What a fish actually does can be broken down into pre-spawn, spawning, and post-spawn periods. Knowing what happens at what time becomes critical in catching fish. Spawning is a complex biological process that takes precedence over the fish's other biological processes. For some species, reproduction signals a modification in colouration or morphological changes. Some fish spawn each year after reaching maturity, while others spawn only once and then die. The time to attain maturity varies among species and individual fish.

To survive and eventually spawn, a fish must feed and grow. Its diet and habitat play a critical part in its growth and how quickly it converts food to energy and weight. Basic factors govern feeding and dealing with predator/prey relationships. Researchers have developed general guidelines on how fish feed and their food preferences. Those that feed most successfully survive to maturity and spawn.

NARRATIVE

Reproduction

Spawning Cycles as Behaviour Regulators, Fish Movements

The biological urge to spawn totally overrides other more typical behaviour patterns. Reproduction is vital to the continued survival of each species and must be accomplished successfully by each generation. Reproduction generally follows three basic methods. In most instances, the female deposits eggs in the water, which are immediately fertilised by sperm from the male. It is not unusual for more than one male to fertilise the eggs of a single female. Another method involves fertilising the eggs within the female's body before they are deposited in the water. In the third situation, the female retains the eggs within her body and the young are born alive. Certain sharks and rays fall into this category along with guppies, mosquito fish and others.

A fish must become sexually mature in order to spawn. Age at maturity varies with the species. The shorter time a species lives, the sooner a member reaches sexual maturity. Species such as tailor and mullet tend to spawn every year once they reach maturity. However, Tasmanian salmon require two to five years before they spawn, Some eel may only spawn every 10 to 12 years and then most species die. Researchers understand how the external factors of temperature, water quality and the diurnal period (amount of light) trigger the spawn, but definitive work on the internal mechanism has not been conclusive. Suffice to say that nature makes certain that the urge to spawn and the development of eggs or sperm take place at the correct time.

It is important to recognise that even when spawning conditions are ideal, all fish of a given species do not reproduce at one time. Usually the spawn is spread over a period of time. If all the fish in an area deposited eggs on the same day, a condition such as the water temperature suddenly dropping would destroy all of the eggs. Some species do not drop all of their eggs at one time, spreading the actual spawn over several days and locations. This spacing also assists in the percentage of eggs hatching.

Each species favours a certain habitat for spawning and subscribes to a particular pattern. During the pre-spawn period, a fish begins to change its behaviour pattern and moves into position for the actual spawn. This movement may be small, such as when bass or catfish pick a site for a bed.

Stream trout in some of our inland waterways may leave their preferred feeding territory and work their way to the headwaters or up a tributary to spawn. The Tasmanian salmon epitomises the spawning urge by ascending the river until it reaches the stream near the spot where it was born. This is accomplished through its sense of smell. As a juvenile, it received a chemical imprint of the water where it grew and the salmon uses that data to return. Spawning salmon work their way over small waterfalls, up well-designed fish ladders, and around most obstacles until they arrive at their ultimate destination.

Mangrove jack swim in from the sea, but their goal is to find brackish water of the right salinity to hold their eggs in suspension until they hatch. The eggs must be deposited in a location where the flow of the river is such that the larvae hatch in water of the correct salinity.

The long and short finned eel spawns in the Coral Sea. It leaves the coastal rivers along the Queensland coast and makes its way to that ocean location where reproduction occurs. Then the young eels or elvers must find their way back to the rivers to survive, and to live and grow, over a number of years until it is their turn to return to the Coral Sea to spawn.

Fish that are ready to spawn are heavier because of the roe (eggs) or milt (sperm). The eggs in a female may account for as much as 25 percent or more of her body weight, while the milt in the male could account for 12 percent of its body weight.

From an angling standpoint, knowing the time of year that various species spawn and where they go is a vital factor in successful fishing. One might raise the question as to whether it makes sense to attempt to catch spawning fish or if it is better to allow them to reproduce before trying to land them. Some species such as the eel tailed catfish do not feed during the spawning period, although fish can be tempted into striking a bait or artificial lure either out of habit or in an attempt to drive it away from the nest.

Breeding

Breeding takes place in several ways, depending on the species. Some species congregate in huge schools such as mullet, tailor and coral trout, when it is time to spawn. In these cases the water temperature and phase of the moon coincide and trigger the fish to spawn in mass where eggs and milt are released, forming a huge mist. The sheer volume of fertilised eggs ensure that many will survive in the currents until they reach a certain size in their development when they can form themselves into small schools for safety. Others gather in smaller groups in protected structures, seagrass or mangroves. A female may spawn with several males. When it occurs it is likely that the eggs are fertilised once they are deposited.

The large female barramundi lies on her side drifting with the tide near the surface of the water. She uses her tail to control her floating movements and position. As she releases her eggs the smaller males slide over her releasing their milt. The eggs are then broadcast in the tidal flow. Tarpon have a ritual of forming a circle called a daisy chain, swimming around and around. Certain species pair off, frequently building a nest to hold their eggs. A typical example is in the freshwater where a pair of eel tailed catfish builds a volcano type nest in the gravel river bottom with their tails, and aggressively defends the territory. Luderick gather around fallen mangrove trees in deep fast flowing waters and deposit their eggs on the sunken branches. Whiting and flathead spawn in estuaries where seagrass and mangroves afford protection for the eggs.

Fish that lay eggs are said to be oviparous, while live bearers are called viviparous.
Fish that build nests, which require greater parental care, usually deposit fewer eggs than those that broadcast their eggs at random.

Sexual Differences - Dimorphism

In most species of fish, the only way to tell male from female is to examine the gonads. Fish appear the same and there is no way to identify the sexes merely by looking at them. However there are exceptions; the male Tasmanian salmon and freshwater trout can develop a dorsal hump and a hook type lower jaw at spawning time

Coloration is one way that a fish can recognise a mate. Coloration is described in the Oxford dictionary as, the disposition of colours, which can identify species by the various patterns of colours on their bodies; hence, the reason why it may become more brilliant during spawning.

Male trout and Tasmanian salmon show more intense colours at spawning time. The cuttlefish and squid are examples where the males continually flash brilliant colour changes in order to win a mate. Except at spawning time coloration among males and females is much the same. Individual fish may show darker or lighter shades, depending on their habitats, but there is little difference between the sexes. Coloration is one way a fish can recognise a mate, hence the reason for the more brilliant colours at spawning time.

In many species the female grows much larger than the male. This is certainly true for most of our common species such as flathead, bream, barramundi etc. since from birth until they reach a certain age the fish are males and, upon further growth and development, change into females. Fish such as the barramundi and some cod have a maximum size limit applied because scientists have found that fish at the maximum legal size must be returned to the water because they are all breeding females. Anglers are encouraged to return large fish of any species such as flathead back to the water because they are breeding females, although there is no regulation applied.

Certain species of sharks and rays are easily identified as males because of the two claspers adjacent to their pelvic fin. Females of these species do not have claspers. Some species of sharks and rays give birth to live young which are known as pups, usually born in litters of 20 or more. Also a number of the species lay eggs among the sea grasses, on rocks and coral. When they hatch they begin their life with all the other sea dwellers.

Importance of Spawning Cycles and Seasons

Nature is a complex phenomenon in which inter-dependence is often critical. A gamefish may spawn before a certain baitfish species that later is a mainstay in its diet. That way, the predator is slightly larger than its prey and able to ingest it. Without adequate food, the fry would not survive. In salt water, spawning often takes place during a particular season that coincides with certain tides and currents. The popular tailor spawns offshore along surf gutters. The tailor relies on favourable currents, created by the dominant south east winds, to carry the fry into the estuaries and rivers. The urge to spawn occurs at a time when these conditions are present. Many reef fish rely on the spawning of the coral polyp as a food source for their fry. They spawn at a time prior to when the moon and tides are at their greatest, which act as a trigger for the coral to spawn.

When one considers that only a minute fraction of the eggs and subsequent fry ever make it to adulthood, the odds seem almost insurmountable. To maintain a stable fish population, each mature adult must at least replace itself. When additional fish are produced, populations rise. Anything less than one-for-one replacement results in population decline. However, the amount of fishing pressure directly affects fish populations, as do a number of environmental factors including pollution and physical destruction of habitats.

Foods, Digestion, Nutrition, and Growth

Fish and the Food Network.

To be successful at feeding and growing, a fish must not only ingest food, but must also assimilate that food into its system efficiently. As food enters the blood stream of a fish, it is first used to supply energy for immediate activities and internal functions. Anything left over from this task then goes to build muscle, bone, and tissue as part of the growth process. Some of the excess food can be stored for later use in the form of fat, but that occurs only after the first two requirements have been fulfilled.

Efficient feeding allows fish to expend a minimum amount of energy for the nutritional value received. If more energy is expended than gained on a long term basis, they become weakened and may become prey instead of predator. It could even starve, although that would take a long time. Fish must cover their energy needs for feeding, spawning, migration, defence, and body functions, turning the rest into growth.

Researchers report that most fish must consume a daily amount of food of average quality equal to about one percent of their body weight just to stay alive and active. That means that a 1.5kg murray cod has to ingest about 15 grams of food every day. Therefore, this fish requires almost 5.5kg of food per year just to exist. Experienced anglers know that the murray cod will not chase a lure very far. It probably is not worth the expenditure of the necessary energy to chase the bait any distance.

A fish uses considerable energy when feeding heavily, therefore, frenzies are usually over quickly. A school of predators may attack baitfish, feed briefly, and then return to a normal swimming pace to rest. It is also important to recognise that fish frequently feed when the opportunity is there. They do not have to have three meals a day with snacks in between.

Within any body of water the relationship of predator to its prey is extremely complex. Most gamefish, for example, will devour almost any type of smaller fish, including its own kind. By doing so, the predator limits the numbers of its prey and controls that species. Usually, baitfish live shorter lives than gamefish and reproduce more quickly. If there isn't enough food for predators, they go elsewhere or their numbers drop, providing the prey a chance to recover. A shortage of food affects the growth of a predator and it often reduces the rate of reproduction. An abundance of food causes rapid growth and much greater reproduction. Everything is interrelated.

At times, a fish will specialise on one type of prey, ignoring others. As a general rule, fish tend to take the largest prey that they can swallow easily. That gives them a greater return for the effort expended. They also select and attack one victim at a time. Their strike is very specific and targeted at only one victim.

If prey becomes isolated, disabled, or looks different to the others, it will be singled out and attacked. When baitfish school, it presents a shimmering mass to a predator. It is difficult for the predator to isolate its prey when the school keeps changing position and course. Stragglers or those baitfish that stray from the school are easily picked off.

Food Conversion and Nutrition

Even under the best conditions, fish require at least twelve hours to digest and assimilate food. However, this varies with many factors. This chemical process depends on body temperature. Since fish are cold-blooded, the temperature of the water determines how fast food will be digested. How much a fish has in its stomach has little bearing on the time required for digestion.

A largemouth bass living in 72 degree water would require about 18 hours to digest the food in its stomach. That same task would take almost four days to accomplish during a northern winter. The colder the water, the less food a fish requires, thus needing to feed only every four or five days, or less, in cold weather. Most species rely on a varied diet, but a predator may concentrate on a specific prey if that prey is in abundance. Fish seem to prefer the foods that give them the most energy.

In fresh water, the crayfish is a favourite food, just as the prawn is favourite in the salt water. Studies show that fish, which feed primarily on crayfish, grow much faster than those that prefer other prey. When crayfish are abundant, they become a favourite food and other prey become secondary. A body of water with a large crayfish population frequently produces more than its share of trophy fish. Studies have shown that, of the same species, fish that fed on crayfish alone gained weight, while those that had to chase other food sources such as prawns and baitfish lost weight. This could possibly be attributed to the expenditure of less energy feeding on crayfish.

In salt water, crabs, shrimp, and other crustacea seem to produce similar growth patterns. Perhaps it is easier for a gamefish to catch crustacea than baitfish darting around.

Water temperature is equally important for digestion in the marine environment. Experts think that swordfish come to the surface during the middle of the day to benefit from warmer temperatures and to aid digestion. At least some marine species appear to have a slightly faster digestive process than their fresh water counterparts. The bottom line is that a fish's stomach can only hold so much food. It requires considerable time to digest that food, even when water temperatures are relatively optimal. Until the food is digested and assimilated, the fish probably is not ready to feed again. However, tailor often strike on a full stomach, spitting out small baitfish that it has already ingested.

Fish Growth

A number of factors determine how fast a fish will grow, including the abundance and availability of food, as well as the temperature and condition of the water. Each species has a typical life span. Baitfish such as frogmouth pilchards may only live for a year, while a blue pilchard may live for six to eight years or more. The longer the average life of a fish, the more time it takes to grow and reach sexual maturity. There are numerous 45.5kg yellowfin tuna, but it takes almost a dozen years to reach that size. A dolphin, on the other hand, may only live four or five years and reaches its maximum size and weight in that time.

Theoretically, a fish is capable of growth throughout its life, but the most substantial growth occurs in the early years, as in humans. A study of tailor showed that two year old fish were able to assimilate a little over one-third of the protein they ingested, but eight-year old tailor could barely convert 20 percent of the protein. Also, a younger fish often put three times as much food value to work in growth than an older fish. Body maintenance requires more with larger fish.

As a general rule, the colder the water, the longer it takes a fish to grow. That's because the growing season is so short. Fish that live in warmer waters including those of the same species, grow much faster. For example, barramundi in far north Queensland usually grow larger and faster than family members in the southern waters. Growth is very slow or non-existent during the winter and while spawning.

Since water temperature affects digestion and basic metabolism, fish living in colder water don't require as much food, and take longer to assimilate it. Food and the energy expended to obtain and digest it are the keys to growth. One can forecast growth rates for any species in general terms by looking at the geographic area.

Environment plays a key role in growth. Fish in a body of water where food is plentiful grow larger in a shorter period of time. The same species in a neighbouring waterway where food is scarce are stunted or grow at a much slower rate. Add the quality of the food to the formula, such as crayfish versus shrimps for yellowbelly, and it becomes apparent why one dam or impoundment yields larger fish than another.

Every body of water has a carrying capacity based on water quality, the shape of the "body", and the total biomass it is capable of producing and sustaining. Better quality water can support more life. Gamefish are at the top of the pyramid. Biomass starts with single-celled algae and ranges through planktonic invertebrates to baitfish and finally to the fish those anglers try to catch.

Certain species require more room to exist than others. The murray cod is a prime example. A single adult cod needs an acre or more of water to thrive. Too many fish in a given body of water is counter-productive. Fish tend to produce more offspring of their species when the population is low than when it is high. This is nature's way of maintaining fish stocks at an optimum level.

Turbidity is a limiting factor in a dam, impoundment, stream, river or any other water. When sunlight is blocked, photosynthesis is limited, which affects the amount of oxygen. The silt also settles over the bottom, often destroying eggs during the spawn. Suspended silt goes through the gills of fish, irritates the surface, and sometimes causes them to swim at a slower rate, thus reducing available oxygen.

Carrying capacity is a theoretical limit that cannot be exceeded permanently. Age and growth information is vital to successful fisheries' management and conservation. The goal is to ensure that a fish lives long enough to spawn at least once. Sexual maturity is not reached for years in some species; therefore, these fish must be protected longer. Fast growing, short-lived species can be caught and kept sooner.

Once a fish reaches a certain age and size, growth becomes much, much slower. A trophy fish does not put on weight very easily, even though it can stalk larger prey and may feed heavily. Food supply and water quality are still critical, but some genetic strains of fish grow larger.

Fish Feeding Habits

Many species of fish seldom roam very far from the spot where they were born. It is commonplace for trout to live most of their lives in one small section of stream. Even when they move for the winter, or to spawn, they will return to that exact spot the next season. Fish cannot know that food is more plentiful upstream or down or on the other side of a lake. They tend to stay in one small area, regardless of the food supply. The fry of coral trout are carried by the off shore currents to coral reefs. Here the young fry will seek out a hollow in the reef, which will become its home forever. Each coral trout has a territory, which it aggressively maintains. All the smaller fish and crustaceans in that area become its food source and any other coral trout moving into the area will be set upon.

Pelagic ocean fish have a different life style, moving about constantly. Their movements are dictated by water temperature, currents, and the availability of prey. Frequently, gamefish will follow baitfish migrations, feeding on their prey over a considerable distance. Water depth is often a key to locating certain species. If sailfish are found in 50m of water at one spot, other sailfish will be at that same depth a considerable distance away. No one knows why, but it happens regularly.

Each species has its own game plan for feeding. The flathead, along with the flounder and yellowbelly is an ambush feeder. They prefer to hide or remain stationary, waiting for their prey to come within range, and then strike. The younger of these species may chase prey a considerable distance, but mature fish seldom do.

Anglers always talk about feeding lanes in a stream where food is carried to the fish. Research has proven that there are certain spots, known best to fish, where they feed. If one fish leaves this area, another will replace it. As young fish take a position, they have to yield to larger fish. These positions are so exact that if one photographed a fish in that spot and made another picture a year later, the eye of the fish in the first photograph could be superimposed on the second if the water flow is identical.

Through eons of time, each species has worked out a survival strategy from which it seldom deviates. That is the life style of the species, and young and old live it together. Anglers study and learn these behaviour patterns of their quarry. Once they understand how the fish feed and the habitat it occupies, they have a better chance of success.

LESSON 21

FISH SENSES

Return to Contents

LESSON 21

Fish Senses

Lesson Objectives

Following this lesson students will:

1. Understand how a fish uses the senses of sound, sight, and smell to locate food.
2. Be able to relate knowledge of these senses to a practical fishing approach.
3. Know why these senses are critical to a fish's survival.
4. Be familiar with the lateral line and near field displacement.
5. Understand how some species use their sense of smell to navigate over great distances.
6. Learn how to approach a fishing spot so as not to spook or alert the fish that may be there.
7. Understand how a fish can strike a black lure on a dark night.
8. Learn the effect of fish scents as attractants.

Materials for the Lesson

1. Several types of commercially available fishing scents.
2. A mounted fish or several different species.
3. Photocopies and an overhead transparency of both the external and internal parts of a fish.
4. Photocopies and an overhead transparency of the graphic depicting the range of a fish's vision.
5. Samples of products to mask human odour.
6. Any material on fish senses from manufacturers.
7. Sample of "smelly" bait.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
I. Introduction	It is appropriate that since this lesson covers fish senses that the students utilise their senses. The use of visuals, both photocopied and the overhead transparencies will help the students see the sensory organs of fish. If available, mounted fish provide an opportunity for students to locate the sensory organs. The smell of the "stink" baits will immediately inform students of their effectiveness for fish with highly developed olfactory organs. By the end of the lesson students should be totally aware of how a knowledge of fish senses will help them to be more effective anglers. 1. Introduce students to the objectives of the lesson.
II. Fish Senses	2. Utilising a mounted fish ask the students to point out its sense organs. Does it have a nose? Does it have eyes? Does it have ears? Can a fish taste? Point out that even though a fish can see, hear, taste, and smell, much like a human, their sense organs are somewhat different, but highly developed and efficient for the environment in which they live.
A. Acoustico-lateral System	3. Distribute the photocopies showing fish external and internal parts and use them along with your overhead transparency to discuss the sense organs of fish. Begin with the acoustico-lateral system. The students have already seen that fish do not have external ears or earflaps. However, there are ears buried beneath the skin on either side of the head. Sounds reach the ears through the skin. In some species there is an internal connection between the ear and the swim bladder. This acts as an amplifier, especially helpful for low or soft sounds. 4. Again utilising the visuals and one of the mounted fish, ask the students to point out the lateral line. If they don't know where it is, point it out on the visual and then trace it on the mounted fish. Ask them what the lateral line is used for. After listing their responses, indicate that it is a second sound-detecting system that fish possess. Indicate that: A. Fish are the only vertebrates to have this organ. B. It responds to low frequency vibrations in the water. C. It is incredibly directional and accurate. D. Within the lateral line area is a series of sensors called neuromasts with tiny hairs connected to nerve fibre leading to the brain. These neuromasts respond to water movement and therefore, fish can hear other fish swimming or a lure in the water. The larger the movement of water, the more easily it is detected. E. Fish seem to be able to distinguish the difference between fish moving in a normal manner and those that are injured or impaired. Predator fish recognise these distress vibrations and prepare for an easy meal.

B. Vision

5. Most fish have excellent near field vision. Different from a human, fish do not have an iris that opens or closes as light increases or decreases. Their eyes are fixed, and light enters only through the centre. Discuss the field of vision that fish have. Since their eyes extend from their head, they can see an area of 180 degrees on either side, and their eyes operate independently of each other. The vision of the fish overlaps in front of them, where binocular vision occurs, and the only place they cannot see is directly behind the tail. The place of binocular vision is the only area where fish have depth perception. Ask students if they have ever seen a fish turn toward a potential source of food.

6. Scientists believe that fish can see at least 24 different shades and are also aware of variations in brightness and contrast. Colour is perceived differently under water than it is in air, as humans usually see it. Colours are determined by various wavelengths of light, and are absorbed by water. The longer waves (reds) are absorbed first. Blues and greens are visible deepest in water. The further from an object beneath water, the less visible the colour, until it turns black or very dark. Discuss these factors with students in relation to lures that are popular in your area and also how this could affect their fishing.

C. Olfactory

1. Location of food or Natal Stream

7. The sense of smell is particularly important to some fish. Fish use smell to detect a food source, to receive warnings of danger, and some fish are able to navigate by smell. All fish have at least two nostrils or nares in their snout. Most have four, two on each side. Behind these is a chamber lined with sensory pads capable of detecting minute odours. Fish use tiny hairs called cilia to push water in one and out the other. Those fish with a well developed olfactory sense have an exceptionally large forebrain. Usually, bottom dwelling and deep water species rely heavily on their sense of smell.

Pass around a container of burley for the students to smell. Discuss other types of bait that attract fish by smell and list these on the chalkboard.

Discuss the sense of smell in relation to burleying and the importance of neutralising body odours that can be transferred to lures and baits. Some fish can also detect enemies with their acute sense of smell.

2. Chemical Communication-pheromones

With advanced or experienced anglers, also discuss pheromones.

D. Taste and Touch

8. Fish have the ability to distinguish between sweet, sour, salty, and bitter. Taste is important to species such as catfish, which can also locate food by touch using its barbels. The catfish also has taste buds all over its body, which help it locate food in muddy water. Carp, cod and black drum can also taste their food externally.

III. Why Fish Senses are Important

9. Have a general discussion why it is important to understand fish senses to be a successful angler. It will affect their approach to the water, the behaviour in a boat, their lure or bait selection; nearly all aspects of angling. List the responses of the students on the chalkboard.

10. Distribute any materials related to fish senses that were received from manufacturers.

INTRODUCTION

The nervous system and brain of a fish are poorly developed when compared to higher vertebrates, but these animals are ideally suited to life in the water environment. Their senses are tailored to that medium and function extremely well. Fish are typically near sighted. Underwater vision is usually limited to close range. However, the eyes perform adequately.

The sense of smell in some species is much more advanced than it is in humans. These creatures are not only able to detect a hint of an odour, but follow it to its source. Also, some species have a well developed taste and sample their food before devouring it.

Although fish do not have external ears, they hear with acute precision. In addition to internal ears and sound chambers, fish have a lateral line. This unique system is not found in any other vertebrate. It responds to low frequency sounds in the near field with unerring accuracy.

Anglers often erroneously believe that fish think and remember with the sophistication of humans. Actually, they respond well to conditioning, relying on their senses for survival. These senses help fish to find food and escape from their enemies. Understanding how these senses work gives an insight into the underwater world. Armed with that knowledge, an angler can better approach his quarry and is more apt to be successful when fishing.

NARRATIVE

Fish Senses

Acoustico-Lateral System
Sound travels at a rate of about 1435 metres per second through water, which is five times faster than its speed through air. Fish have developed extremely acute hearing, especially on low frequency sounds ranging from 200 to 800 cycles per second. A typical fish can discern sounds from 30 cycles to about 2,000 cycles per second, which is two octaves above middle C.

Anyone who dives below the surface assumes that the underwater world is silent simply because humans have difficulty hearing in that medium. Science has shown that the opposite is true. A moving school of baitfish sends out sound waves. The noise of a tackle box scraped along the deck of a boat is echoed through the water. Footsteps along the bank send vibrations into the water. Some fish can even hear the sound made by a worm wriggling into the bottom. Fish have become adept at detecting and reacting to these various sounds that signal food or danger.

Humans and other mammals have external earflaps, but these are absent in fish. Their ears are buried beneath the skin on either side of the head, are highly developed and are positioned close together. There are no eardrums and no outside openings where water can get in. Sounds reach the ears through the skin, flesh, and bone of the fish. In some species, there is an internal connection between the ear and the swim bladder. The swim bladder acts as a resonator and amplifier, which is particularly helpful in detecting very low or soft sounds.

Any species that has the connection between ear and swim bladder possesses sensitive hearing. One can speculate that fish that spend most of their lives in fast water do not have as acute hearing as those that live in a still water habitat. Strong hearing capability is not limited to predators or game fish. It is equally important for prey species to benefit from keen hearing as an escape mechanism. By detecting a predator, they can hide or get out of the way.

Fish have a second sound detecting system called the lateral line. No other vertebrate has this organ which responds to strong, low frequency vibrations in the water within a range of 6 to 9 metres. It is sometimes referred to as the sense of distant touch, because it is incredibly directional and accurate. With it, a fish can locate and strike a black lure on a moonless night in turbid water.

The lateral line starts at the head and extends almost to the tail down each side of the fish. It can be seen visually on most species. Within the lateral line, there are a series of canals lined with sound sensors called neuromasts that are totally sensitive to low frequency sounds. The neuromasts have pods of tiny, sensory hairs connected to nerve fibre that leads to the brain.

Near field sound occurs when molecules of water are disturbed and pushed. This slight movement of water disturbs the neuromasts, which send signals to the brain. Far-field sound takes place when molecules are moved back and forth, but are too distant to be pushed very far in one direction. The ears of a fish receive far field sound, while the lateral line deals with near-field displacement.

Scientifically, researchers claim that fish cannot discern the direction of far field sounds, although they can hear them quite clearly and identify them as familiar or threatening. Observations in the field dispute that point. Even in panic, a fish always appears to move away from disturbing sound rather than toward it. Fish do not make a mistake and charge the source of the sound unless they expect food.

When dealing with the lateral line, the larger the cause of the sound, the more easily it is detected. A bigger fish moving through the water pushes more water than a smaller one, which tends to give baitfish warning that something large is approaching.

If one watches a school of fish, it becomes instantly apparent that each school member maintains its position and does not collide with a neighbour, even when the school suddenly changes direction or speed. The lateral line is probably the system that helps a fish keep its distance from the others. When several fish are feeding voraciously, swimming at high speed with sharp turns, the lateral line signals them constantly and they never crash into each other. It boasts amazing accuracy and it is doubtful that most fish could survive without a lateral line system.

For a long time, anglers believed that fish could not hear conversations above the water because the surface tends to reflect extraneous sound. That theory is no longer widely held, particularly in very shallow water or when a fish is near the surface. Serious fishermen communicate in whispers and then only when it is absolutely necessary to talk. One can test this theory by turning on a radio in a boat and then diving under the water. In many instances, the human can hear the radio, even when he is submerged. If he can hear the sound, a fish certainly is able to detect it.

When a fish is injured or its normal swimming impaired, it gives off distress vibrations. These are totally different sounds from those of a healthy creature or one swimming unencumbered. Predators recognise distress vibrations and home in on them from considerable distances with a purpose. They know that a fish in trouble is an easy meal not requiring the expenditure of much energy. And the predator seems to know exactly from where the sound is coming even though it is far-field displacement. There is also some evidence that chemical factors may be involved and help predators locate injured prey.

Sharks are notorious for arriving at the scene of a distressed or expired fish. Spanish mackerel also respond to these distress vibrations as do other predators. A shark or spanish mackerel for instance will appear suddenly when a smaller bait fish is thrashing around alongside the boat. That's one reason why bait fish suspended on the surface will attract game fish.

Feeding within a lake, stream, or salt water often becomes a chain reaction. Fish hear the sounds of other fish feeding and often begin to look for food themselves. The sounds of the tail thumps and splashing can have a positive effect on many fish at the same time.

Over reefs and banks in the ocean, anglers often resort to burleying to attract fish, relying on the smell factor. Burley can consist of chopped up old fish bait, prawn heads and chicken pellets and other old sea food. Actually, smaller fish feeding near the boat may devour most of the burley, almost as soon as the burley begins to sink. Fishermen are sometimes concerned that the burley is not reaching its target, which happens to be larger game fish. Frequently, the sound of smaller fish noisily feeding attracts larger game fish and the mission is accomplished through a combination of sound and smell.

To prove that fish recognise specific sounds, scientists have recorded underwater sounds and then played the recordings in other areas. The sound of porpoises, for example, caused mackerel to panic and display fear. A shark was lured right up to an underwater speaker that was broadcasting the sound of feeding yellowtail. In freshwater, trout have been observed to begin feeding vigorously when they heard sounds of other trout feeding.

Certain sounds attract and others repel. A sudden noise will often cause a fish to move off before it stops, turns, and begins to investigate. Even a tiny, light-weight lure that lands over a fish may cause a negative reaction temporarily. It's much better to make the presentation beyond where one suspects the fish to be.

Vision

A game fish may use its sense of smell or hearing to locate its prey, but in most cases the final attack is visual. Predators enjoy excellent vision underwater and they use it to isolate and attack their victims. Fish have eyes very similar to those of humans with a few basic exceptions. One major difference lies in the fact that humans have an iris or diaphragm that opens or closes depending on the amount of light. A fish's eye is fixed and light enters only through the centre. Light is blocked when it comes from the edges.

Basically, light comes into the eye, is focused by the lens, and directed to a light-sensitive screen in the back called a retina. The eye of a fish is round and it does not change its shape in an effort to focus. Human eyes are flatter in the front and the lens adjusts to focus the light on the retina. This inability to adjust the shape of the lens causes nearsightedness in fish, allowing them to see clearly at relatively short distances, but items are blurred beyond that. By using a muscle called the retractor lentis, fish can extend their vision. This muscle comes into play only for distance vision and it pulls the lens back toward the retina to focus. The lens in a fish's eye is already set for near vision so the muscle is used only when distance is needed.

Even under the best conditions where the light is unusually bright and the water exceptionally clear, vision is limited to approximately 15 metres. In most conditions, underwater visibility is less than 15 metres often much closer than that. Typically, almost 99% of the light is filtered out in the first 6 metres below the surface. In murky water the majority of light will disappear within the first 3 metres.

It is important to understand that vertical depth and horizontal distance have the same effect on visibility, although looking horizontally within a few centimetres of the surface provides the benefit of more light.

Since fish do not have an iris, they adjust to changes in light through receptor cells. Most fish have both cone and rod receptors. Cone cells are used during periods of brightness when the light levels are very good. During periods of poor visibility, the rods take over. The rods are about 30 times more sensitive than the cones, but they record only in black and white. The process of changing from rods to cones or vice versa is not instantaneous since it requires at least two hours to switch completely.

During a normal, twenty-four hour period, the process is ongoing. Late in the afternoon, the cone receptors retract and the rods start to come forward. Sometime during the night, the reverse takes place and the fish is ready for the coming of daylight. Predators rely on these rhythms for an advantage in feeding. Anglers know that some of the best fishing takes place very early and again late in the day. Fish feed at these times because they have an advantage in being able to sneak up on their prey and expend less energy.

When a diver drops below the surface of the water, he must turn his head constantly to check around him. He can see only directly in front and is severely limited with a form of tunnel vision. Fish don't have that problem. Instead of having recessed eyes as humans do, theirs are round and extend from either side of the head. Each eye can scan independently of the other, covering an area of 180 degrees or more on either side. There is an area of overlapping in front of the fish, forming an angle of about 45 degrees, where binocular vision occurs. The actual angle varies with the species. The only place a fish cannot see is a narrow lane directly behind the tail.

The sharpest vision occurs when an object is at right angles to the eye, but there is a trade off. The only area in which a fish has depth perception lies in the zone of binocular vision. That's why one often sees a fish adjust its position to turn toward a possible source of food. This binocular "vee" starts in front of the fish and not directly against its nose. If a bait or lure passes too close to the fish, it may be difficult or impossible for the fish to see it. The presentation should be at least 300mm or so in front. For some species, a presentation at right angles to the eye will bring an instantaneous response as the fish whirls, brings the offering into binocular vision, and strikes.

Fish, like other predators, are alert to any movement. It is more than a conditioned reaction. The beam of light striking the retina moves when the object in view moves. That excites the nerves in the retina and the information is transferred to the brain.

New anglers often question whether or not fish can see colour. Scientists point out that the presence of cone receptors in the eye, indicate that a fish has the ability to distinguish colour. This occurs in practically all of the fish that live in relatively shallow water. Many species of game fish have the ability to distinguish at least 24 different shades and are aware of variations in brightness and contrast.

Colours are determined by various wavelengths of light. An object absorbs all but one wavelength, which is reflected back. The eye sees that object as a single colour. Violets and blues are at one end of the scale, while oranges and reds are at the other. Humans are familiar with identifying colours through the medium of air. Water has a different effect, tending to absorb the longer waves (reds) first. Red will disappear within 4.5 to 6m of depth or horizontal distance. Blues and greens penetrate the deepest in water. As a point of reference, the human eye sees chartreuse better than any other colour and it is assumed that the same holds for fish.

As depth increases, the loss of colour does not occur all at once. A red or yellow or any coloured object tends to fade rapidly. The colour simply isn't as bright. Eventually, it turns black or a very dark shade when the colour is lost. Remember that black is the absence of colour, but white is the presence of all colours.

At one time, fishers were led to believe that certain fluorescent fishing lines were highly visible above water, but could not be seen underwater. It was later proven beyond doubt that this statement was in error. Fluorescent colours underwater are much more visible than non-fluorescent colours and fluorescent line actually appears to have a greater diameter than it actually does.

The background plays an important part on how visible a particular colour might be. Certain shades tend to disappear against various backgrounds and it depends whether a fish is viewing the colour looking up, down, or horizontally. Keep in mind that a fish looking up at a lure sees the lure in silhouette against the sky. It is the same as looking at a bird against a bright sky and trying to identify the colouration under the wings. In many cases, one can distinguish only shades of black, white, or grey and note the contrast. Similarly, that is the way a surface lure can look to a fish. As a general rule, consider that most predator fish have excellent vision and they can see colour. Their biological rhythms prepare for the coming of darkness and the arrival of dawn. Vision is vital in the final stages of attack and feeding. Fish may reach their prey through smell or sound, but will then switch to the visual mode before striking. Much, of course, depends on the clarity of the water.

Olfactory Senses

The olfactory senses are particularly important to many fish species. With it, they can pick up the scent of a food source, receive warnings of danger, and allow them to navigate by nose. All fish have at least two nostrils or nares in their snout. Most game fish as well as other species have four nares, two on each side of the snout. That's where the similarity to mammals ends. Air breathers have a tube from the nostrils that lead to the throat; fish do not.

Behind the nares on a fish is a chamber lined with sensory pads capable of detecting minute odours. The key to keen smell is the ability to move water over these pads rapidly. Fish use tiny hairs called cilia to push water into the chamber. The double nostril system allows fish to push water in one and out the other, ensuring a stronger and faster flow. A pumping system using the cilia or moving the gills is important. Otherwise, the system is effective only in flowing water or when the fish is swimming.

Smell is handled by the forebrain in the fish's head. Those with well-developed olfactory senses have an exceptionally large forebrain. Traditionally, bottom dwellers and those species living in deep water rely on their sense of smell a great deal, but it is often important to those fish that inhabit shallow water. Any species that does feed at night probably has a well-developed sense of smell.

Burleying, the technique of broadcasting natural food in a current, demonstrates that fish can use their sense of smell to track. They will turn into the burley slick and follow it to its source. Game fish often use smell to track a food source and then switch to vision when they are close. Many, however, have the ability to find food by smell alone.

Experts have difficulty explaining how a fish can sort out thousands of odours in a body of water and react to the ones that are important. Species such as the salmon can respond to traces of a chemical in such small quantities that sensitive instruments have trouble measuring it.

Smell is also used to detect the presence of enemies. During one test, the fish detected the odour in concentrations of one part per 80 billion. It is precisely this sense of smell that may allow the salmon to return to a stream and the precise spot of its birth. No one fully understands how the salmon does it, but researchers have proved that it involves the salmon's ability to detect minute quantities of various smells.

Repeated experiments have shown that fish react negatively to certain smells that spell danger such as those given off by a bear paw or the human hand. Humans have a substance called L-serine which is an amino acid. When they touch bait, a lure, line, and so forth, this substance transfers and the fish can smell it. Expert anglers often rub one of the fish scents, a neutralising chemical or even natural bait over their hands to mask the scent normally given off. It really makes a difference in catching fish.

Pheromone is the term describing a smell that is used for some form of communication among fish. Baitfish, for example, often panic at the smell of a wounded school member. There is a substance in the skin of baitfish called schreckstoff, "fright substance," and it is visible under a microscope. When a predator grabs or eats a baitfish, schreckstoff is given off and it warns the other baitfish to stav clear of the area. Certain juvenile fish recognise the smell of predators and scientists believe this is natural instinct rather than learned.

Smell is used among school members for various rituals including mating. It is an important sense, but one which humans have difficulty understanding because our own olfactory senses are less than accurate. Certain feeders such as catfish or sharks depend heavily on smell to locate their prey and can accomplish that with unerring accuracy.

Taste and Touch

No discussion of the senses would be complete without at least passing mention of taste and touch. Fish do have the ability to distinguish between sweet, sour, salty, and bitter, although it is questionable how much taste is used by most game fish. Taste is important to locate food by touch using barbels, the whiskers around the mouth.

Taste buds are usually external, but internal ones occur in some species. The catfish has taste buds all over its body, including its tail, which help it to locate and select food in muddy or silty water. As mud is stirred up, the sense of smell becomes confused and that's why touch and taste suddenly become important.

Some species of fish have the ability to taste their food externally. These species often test their food first before they take it in their mouth. That's why those who fish for these species are patient and wait until the fish runs off with the bait before setting the hook.

Why Fish Senses Are Important

The immediate desire to catch fish often overshadows the more logical approach of understanding them first. When an angler knows how a fish feeds and the ways in which a fish uses its various senses, he is better equipped to meet the challenge of fishing. Simply drowning a bait or mechanically cranking a lure spans a very narrow angling corridor. It becomes a hit and miss effort that lacks consistency.

Each fish species has its own life style and even within a given family of fishes, there are subtle differences. Rainbow and brown trout may be found in the same stream, but they are not the same fish and show distinctive preferences and habits. A basic familiarity with tackle and techniques may give an angler an excellent start, but only through an understanding of the habits and habitat of the fish will an angler become accomplished.

How to Approach Fish

Most species are acutely alert to what is going on around them. They have keen eyesight that encompasses almost 360 degrees, leaving only a small zone behind them as a blind spot. Fish also have the ability to see out of the water and spot anglers just as easily as fishermen can see the fish.

When a person looks at a fish underwater, the fish is actually closer than it appears. This is because light rays bend or are refracted as they pass from the air into the water. From the fish's viewpoint, refraction creates a periscopic effect. An angler standing on the bank does not appear to be on the bank, but almost directly over the fish. Any movement and the fish knows instantly that something is unnatural.

Once a fish has been alerted, it is more difficult to catch than one totally unaware of a fisherman's presence. That's why the approach is so critical. Fish always face into the flow of water. In moving water, serious anglers work upstream into the current. They are taking advantage of a fish's blind spot to its rear. The swifter the current or the deeper a fish happens to be, the more difficult it is for the fish to spot a person.

When walking along the bank, the angler transmits sound and vibrations of footsteps into the water. If small mullet are in the shallows, one can see them ease into deeper water as an angler approaches. The answer lies in staying well back from the edge of the water and then keeping a low profile. White or bright coloured clothing is easily seen by fish. Shirts, trousers, jackets, and hats should be coloured to blend into the background.

The commando tactic of keeping low is very valid when approaching a stream, pond, lake, or anything else on foot. The closer to the ground one happens to be, the less likely a fish will see him. Even when casting, it is important to keep the rod tip fairly low. If a fish detects movement in the rod, it will become very wary.

Aboard a boat, silence is the golden rule. Any sound transmitted through the hull and into the water telegraphs the position of the boat. Bright clothing makes anglers visible and movement is quickly seen. Too many fishermen roar into an area at high speed, sending damaging waves against the shoreline and alarming fish with the sound of the engine. It makes more sense to enter the fishing zone slowly and preferably from a direction where you don't expect the fish to be. Running over them may force them to change locations before the first cast is made.

The best advice is to think through each situation, remembering that fish see, hear, and smell very well. Approach quietly and without being seen. Keep the noise level down and maintain a low profile, minimising movement. The results of these tactics will be obvious.

LESSON 22

FOOD CHAINS AND ECOLOGY

Return to Contents

LESSON 22

Food Chains and Ecology

Lesson Objectives

Following this lesson students will:

1. Understand the basic relationship of fish to their environment.

2. Know the importance of carrying capacity and dissolved oxygen content.

3. Know why energy flow is important to ecology.

4. Be familiar with aquatic food chains and the interrelationship of producers, consumers, decomposers, and predators.

5. Understand predator/prey relationships and how they apply to the food chain.

6. Comprehend how to use food chain information to catch fish.

Materials for the Lesson

1. Overhead transparencies and photocopies of the appropriate graphics from the appendix.

TEACHING STRATEGY

Lesson Content Outline

Classroom Procedure

Due to the content of this lesson you may want to invite a fisheries' biologist to participate and discuss many of the scientific aspects of this subject. He/she may also be able to bring a film or film strip to illustrate some of the material.

1. Introduce students to lesson objectives.

I. Basic Ecological Principles
A. Energy Flow
B. Carrying Capacity
C. Dissolved Oxygen and
D. Recycling

2. Begin the discussion by informing the students that angling success can be increased if they understand several basic ecological principles and how aquatic chains work.

3. Explain that aquatic life is based on an energy flow, with Water Temperature a broad base and a narrow peak, much like a pyramid. Top predators, and especially those fish that are the most exciting to catch, are at the top of this pyramid. Using the graphic, explain this energy flow and the fact that only about 10% of the energy at one level is passed on to the next. Explain that the base of the pyramid of the ecosystem are the primary producers, which rely on the sun. The energy possessed by these plants is passed on to plant eaters, which are the first level of consumers, which are eaten by the meat eaters, and so on up the line. Each species of aquatic life finds its niche in this flow of energy.

4. The previous discussion leads directly into the carrying capacity of bodies of water. Each is limited in the number of living things that can be present. Water quality has a great effect on carrying capacity, as does the food supply, and the amount of competition. Some waters are much more productive than others based on their depth and the length of the growing season.

5. Fish need oxygen to live and through the process of photosynthesis, aquatic plants supply this to aquatic life. Water quality, and water depth, allowing the sun to penetrate plants, allow this process to continue. Turbidity, pollution, ice covered with snow, and plant decomposition can retard this. Also, the warmer the water, the less oxygen it can hold and the more needed by fish.

II. Aquatic Food Chains
A. Producers
B. Consumers
C. Decomposers
D. Predator/Prey
E. Using this Information in Fishing

6. Every living thing belongs to a food chain. The sun is the basic source of energy. Lead a discussion of the role of producers, consumers, decomposers, and predator/prey relationships around the concept of a food chain. Ask students to relate this concept to their own lives and then to that of fish in the aquatic environment.

7. The concepts presented in this lesson have much significance for anglers. Ask students to draw conclusions of how this knowledge can help them become better anglers. The text can provide much useful information and suggestions.

INTRODUCTION

The word "ecology" escaped from the scientific lexicon in the late 1960s and entered the public domain as a rallying cry. People suddenly focused their attention on environment, bemoaned pollution, worried about wetlands, and talked recycling. By definition, ecology is the study of the way in which all forms of life relate to their environment, which includes each other. It does not mean a clean, pollution-free earth.

Life cannot exist in a vacuum. There are interactions with living organisms as well as the non-living. A definite energy flow exists. Survival for a given species in a watery world may seem simple, but it becomes part of an intricate web in which one factor depends on another and another.

The aquatic food chain consisting of producers, consumers, decomposers, and predators showcases life's interdependency under the surface of a pond, stream, lake, estuary, or ocean. Dissolved oxygen and water temperature become vital factors in any life support system. Each body of water has a carrying capacity that regulates the number of animals within a given area.

Knowledge is an angler's strongest ally. Understanding the food chain and how each species relates to its environment become significant factors in locating and catching fish. It also serves as the cornerstone in protecting the habitat.

NARRATIVE

Basic Ecological Principles

Ecology focuses on interactions and interrelationships of organisms and their environment. There are specialties within the discipline through which the researcher or observer goes beyond the individual or the species to concentrate on behaviour, population, the community, and the ecosystem.

From the practical standpoint of fishing, ecology considers such factors as water conditions, nearby objects, available food, potential enemies, and the watery environment in general. It is difficult for air breathing humans to understand what it is like to live beneath the surface of the water. As a medium, pure water is tasteless, colourless, and odourless, but it is 780 times as dense as air.

Anyone who has attempted to swim underwater knows how difficult it is to propel the body. Fish seem to do it with ease, benefiting from a particular shape or form that has evolved over time. Water also creates neutral buoyancy that counteracts the effects of gravity. A relatively small person can support a 100kg man in the water with one hand. Fish live in a weightless world.

The air around us contains about 18% oxygen, which is vital to our survival. Fish also need oxygen, but the amount dissolved in water is much, much less. Typically, water contains about .0008% oxygen which translates to eight parts per million. To glean this vital gas from water, animals living in that medium must develop highly efficient gills. A difference as minute as one or two parts per million can determine whether or not a fish can survive in a given body of water. Think of the effect on humans if 1/3 of the oxygen supply were removed.

The human body is composed primarily of saline water. That's not really a problem in a relatively dry atmosphere, but it is to fish. They, too, contain a considerable quantity of salt water. Only a thin layer of skin separates this fluid from the water around them. In the ocean, osmosis through the skin takes water out of a fish's body and the animal must replenish it by drinking sea water. Just the opposite occurs in fresh-water. Reverse osmosis causes water to enter a fish's body through the skin. Since the body fluids are saline, this freshwater must be flushed through the kidneys. It's equally important to know that dissolved particles in the water enter the body the same way. That's why the flesh of certain fish can contain chemicals found in the water in which they swim.

As a basic ecological rule, the more tolerant of varying conditions an organism happens to be the better its chances for long-term survival. Those that can exist only within a narrow band are at the mercy of the vagaries of nature.

Energy Flow

Energy flow becomes the common denominator (medium of exchange) for any ecosystem. Within any food chain, there is a transfer of energy. Radiant energy from the sun is vital to the plants, which are the primary producers. This energy is stored by chlorophyll containing plants as sugars or carbohydrates. Herbivores or plant eaters are the first level of consumers. Carnivores or meat eaters feed on herbivores and other carnivores. Omnivores feed on both plants and meat.

The chemical energy used at each level is not recoverable. As part of the process and particularly through respiration, heat is given off into the atmosphere. At each level of the food chain, there is less energy available than at the level below. This is an important concept and involves the ten percent rule. Only ten percent of the useful energy at one level will be passed on to the next level. This creates a pyramid effect with a broad base, steep sides, and a narrow peak. Top predators and particularly those fish that are most exciting and rewarding to catch sit at the top of the pyramid. That's why there are so few of them compared to baitfish and other creatures of the underwater world. In this sense, fisheries management, centred on predators, becomes quite different from wildlife management, which concentrates on prey animals. The living creatures in an area become part of a very complex system of energy relationships known as a food chain or a food web.

Each species finds its niche in the web in terms of foods it will eat and in the places it can live. Most creatures try to eliminate as much competition as possible through unique adaptations. Those animals that can tolerate and digest a varied diet have a better chance for survival.

Carrying Capacity

Every body of water, including the oceans of the world, have finite limits on the number of each living thing they can support. This ceiling or upper limit is called carrying capacity and it is affected by several variables. Water quality and condition may control a given species directly and indirectly. In the direct sense, the spawn and juveniles may be limited. Indirectly, if the biological productivity of the water in terms of food supply drops, the carrying capacity immediately reflects this change.

It is not uncommon to find vast quantities of spangled perch in a farm pond, victims of competition for a dwindling food supply. Overcrowding produces its own effects. Scientists believe that many species limit production of young when conditions are crowded, but expand the spawn when an area is available for repopulation.

Food supplies play a vital role in determining the carrying capacity and the size of the fish in a particular body of water. The concept focuses on the pyramid discussed above and the ten percent rule. Barramundi require a large area to forage and there are seldom very many of them in any lake or river. It's no wonder that to produce and sustain a single 10kg barramundi requires a base of about 100kg of herring annually. 100kg of herring depends on one tonne of shrimp. Those shrimp rely on 10 tonnes of zooplankton for their survival and the zooplankton need 100 tonnes of plants (phytoplankton) for their support. In this example of a pyramid, it takes 100 tonnes of plants for one 10kg barramundi.

The amount of food available and the competition for it plays a critical role in determining how many of any species will reside in a body of water and the size they will attain. Research has shown that medium sized lakes usually produce more fish per hectare than large ones. Shallower freshwater catchments and estuaries boast more productivity than deeper ones because of greater shallow shoreline where sunlight can reach the bottom over a greater area. Growing season also plays a part. In regions of Queensland where the weather is warmer and the growing season is longer, freshwater catchments and estuaries yield greater returns. The richest areas in marine environments are mangrove communities and seagrass beds. Both of these occur in shallow water. The deep ocean can be compared to a marine desert with a lot of water and very few fish. Coral reefs rely on algae in the coral polyps as a start to their food chains, and clear relatively nutrient poor water. This situation gives rise to the large number of species but low numbers of each species found there.

Importance of Oxygen and Water Temperature

Without an adequate supply of oxygen, fish cannot survive. There is no substitute, so it becomes a critical ecological limitation. Aquatic plants take in carbon dioxide in the water and give off oxygen with the help of the sun. This process is called photosynthesis. When the water is unpolluted and relatively shallow, rooted plants and floating algae ensure the necessary oxygen for other forms of life.

Additional oxygen enters the water from the air, although this is a slow process. In a moving stream, or in the ocean, water in breaking waves, tumbling over rocks or cascading over falls picks up quantities of oxygen from the air. However, if the water has too much oxygen, it will release the excess into the atmosphere until it maintains a fully saturated condition.

Murky water screens out sunlight and makes photosynthesis more difficult. Turbidity, in the form of silt, also settles on the bottom, smothering plants, corals and even the eggs of fish. When the water becomes over fertilised and polluted, there is usually a serious lack of oxygen. Decomposition of plant and animal life uses up a considerable amount of oxygen, often compounding the problem.

Fish tend to linger in weed beds during the summer months. Fish will also congregate where underwater springs enter a lake. In a stream, look for fish near riffles and fast water when oxygen supplies dwindle.

There is an important relationship between oxygen and temperature. The warmer the water temperature, the more oxygen a fish requires and the less the water can hold. Water temperature is perhaps the single, most important factor in determining where fish will be and how they will behave. These are cold blooded creatures with body temperatures that adjust to the temperatures of the surrounding water. Rapid heating or cooling of water stresses their physiological processes. A fish caught in water that cools quickly may die.

Each species has its own comfort and tolerance level. They tend to seek the most comfortable environment, assuming, of course, that there is adequate oxygen. For the angler, a thermometer is one of the most vital items of fishing gear. Sometimes, a temperature variation of only 1°C will spell the difference between fish and no fish as they can sense minute variations in temperature and respond to them. It can be extremely important to monitor temperature at all times.

There are some general observations worth remembering. Shallow flats warm and cool more quickly than deeper water. During a cold snap, fish will leave the shallows for the depths, but return when a warming trend develops. When the heat of summer raises water temperatures, fish tend to move into deeper parts where more comfortable temperatures prevail. Freshwater anglers know that early in the morning, some of the best action occurs in coves and backwaters, because temperatures are slightly warmer than in other parts of the river or impoundment.

Recycling

Although the energy flow through an ecosystem is lost, certain chemicals and nutrients must be recycled if the process of generating new energy is to continue. Water evaporates and then falls to earth again in the form of rain or snow. The runoff into streams, lakes, estuaries, and eventually the ocean carries chemicals and nutrients.

Every organic compound contains carbon and hydrogen. Carbon is separated during photosynthesis and then put back in the form of carbon dioxide through respiration, fermentation, or combustion.

The decomposers use oxygen and give off carbon dioxide.

Oxygen unites with hydrogen, to form water. During photosynthesis, a separation occurs and oxygen goes back into the atmosphere. Certain plants produce nitrogenous materials and this vital nutrient completes its cycle. These, of course, are simplifications of extremely complex, but vital processes. Without the recycling of these chemicals, life simply would not exist. There are other nutrients necessary, but carbon, hydrogen, and nitrogen are the primary ones.

Aquatic Food Chains

Every living thing belongs to a food chain. These chains are not isolated, but actually part of extremely complex food webs. The sun is the basic source of energy. Oxygen and simple foods are produced through photosynthesis. Food is vital for an organism to repair tissues, to grow, and to have energy for basic body functions.

Plants form the broad base of the pyramid, converting the sun's energy into their own food. Rooted plants streaming upward from the bottom of the water are extremely visible, but the food chain usually begins with one-celled, microscopic organisms so tiny that they are almost impossible to see with the naked eye. These plants are called "phytoplankton". "Plankton" is all of the small life in the water. "Zooplankton" defines extremely small animals that feed on the microscopic plants.

Larger aquatic animals including many species of fish feed on both phytoplankton and zooplankton. They, in turn, become meals for larger fish.

Producers

Green plants take the energy from the sun, along with water that supplies hydrogen and carbon dioxide, and create their own food, giving off oxygen as a byproduct. These are the producers and animal life cannot exist without them. They are the basis for all life on earth. Because these plants are self-sufficient, they are called "autotrophs" from the Greek "auto" meaning "self" and "trophein" meaning "to nourish".

Plants have the ability to manufacture sugars, fats, proteins and other compounds from basic inorganic materials. Animals lack the ability to do this. Primary production measures the rate at which plants convert inorganic materials to food. The plants for their own survival use some of this food. The excess or net primary productivity determines the amount of food available for other life forms. The more food the primary producers make the greater the ecosystem that can be supported.

A significant percentage of the food produced on the primary level is lost to the next level. Not all of the plants and the phytoplankton are eaten. Some die of natural causes and become detritus for the decomposers. This is also an important function, because in the process, certain vital chemicals are returned to the system.

Rate of conversion must also be considered. The faster the energy from the producers is transferred to the next level, the smaller the loss of energy. Consider that plankton may bloom (reach abundance) in a day or two, but it takes the better part of a year for certain rooted plants to form and begin to grow.

If animals throughout the food chain are to survive, there must always be more food than necessary at each level. This enables the food sources to reproduce and renew themselves. If they are completely destroyed or seriously diminished in a given area, it would have a catastrophic effect on higher orders that depend on the food chain for their survival.

Consumers

Animals and non-green plants do not manufacture their own food and cannot be considered self- nourished. They are called heterotrophs meaning that they are "other-nourished". The basic animals in this group are herbivorous, relying on green plants for their food. Because they feed on the producers, they are considered to be consumers of the first order and include zooplankton, worms, shrimp, clams, insects, and even some fish.

The food gleaned from plants by herbivores or first order consumers must not only provide energy, but very specific organic compounds and nutrients. The absence of any of these, even for a very brief period will stop the production of protein. An imbalance will change the metabolic rate and prolonged absences of vital chemicals will cause death.

The carnivores, or meat eaters, form the second order of consumers. Some scientists call these animals foragers. They must expend considerable energy to search for their food and capture it. Species that fall into this group must disperse their young where there is an adequate food supply. Many of the panfish such as bream and whiting fall into this category along with garfish, yellowtail, and slimy mackerel.

It is within this group that the delicate balance of nature first becomes somewhat visible to the lay person. If these carnivores destroy most of their food source, they and their offspring will perish through starvation. That enables the first order of consumers to re-establish itself so that the balance can be achieved once again. Seldom, however, does a carnivore totally eliminate its supply of food. Very few organisms depend on a single food source for survival. The dugong with its dependency on the seagrass is an exception.

Predators sit at the top of the consumers, preying on first and second order fish. These are the game fish that many anglers want to catch and include barramundi, marlin, bass, trevally, mackerel, tuna, tarpon, and tailor. It takes a staggering amount of productivity and energy transfer on the lower levels to support a meaningful population of these predators.

Decomposers

Organic compounds remain trapped in dead plants and animals, waiting to release that energy back into the system. Bacteria, yeasts, and microbes are described as the non-green plants and they wait to break down detritus and dead animals. Scavengers have a digestive cavity that simplifies food for assimilation. The decomposers secrete digestive juices directly on the plant or animal. Decomposers can remain dormant for extended periods of time, conserving their energy and waiting for the opportunity to feed on dead plants or animals. They multiply at an incredible rate once food is present. Even the wastes from the decomposers are utilised and further broken down by other organisms.

The basic nutrients released through this process go back into the system to be used by plants during photosynthesis and by other animals in their battle for life. Not all decomposers work rapidly. Some take considerable time before they can adequately complete the recycling phase. Certain chemicals such as those used in some pesticides and herbicides can only be attacked by a small percentage of the decomposers and even that takes a long time. Scientists are concerned that these substances will linger in certain ecosystems for long periods of time.

Wind, currents, water flow, and other factors help to distribute the decomposers. They continue to travel until they find the right conditions. Then, they tend to remain and produce more of their species until the job is done. Most decomposers are specialists working only on a limited portion of the food source. One might think of the process in terms of a disassembly line.

Predator/Prey Relationships

Predators remain close to their source of food. Some lie in ambush, protected by natural structure and their own colouration until a victim comes within the range. The capture occurs with lightning speed as the predator lunges out at its prey. Australian bass, sooty grunter, barramundi, cod, mangrove jack, coral trout, flathead and even the flounder often employ this technique.

The alternative lies in cruising around until prey is located. Most of the pelagic ocean species such as bluefin tuna, mackerel and trevally follow this procedure, often forming schools for increased efficiency. A school of predators has the advantage of disrupting and disorienting its prey. The baitfish are not certain which predator is about to attack, so it is more difficult to avoid an aggressor.

A predator selects and attacks one specific victim at a time. When baitfish school, it is difficult for a predator to select a single member and charge it. The facade of the school becomes a shimmering mass that changes constantly.

Anyone who has monitored gamefish behaviour knows that predators often lurk below their prey, which allows them to pick off one that looks disabled or different. The effect of this predatory system is to cull out the sick and the young. By doing so, predators are not greatly decimating the total food supply in the chain or web.

A baitfish that strays from the pack becomes an easier target and is frequently attacked the moment it gets separated. If there is something different about a specific fish that enables the predator to maintain eye contact with it, that fish is in serious trouble. Scientists report that most predators look for the easy meals and ignore the healthy fish in the middle of a bait school. Some species will charge bait in the hope of causing disorientation, but the successful predator still runs down its victims one at a time.

The prey sometimes becomes the predator at certain stages of development by feeding on eggs, fry or juveniles. There are many fish that raid the nests of other spawning fish and eat the eggs. Once the eggs hatch and the fry scatter, they become fair game for many of the species that will later become the prey. In this reversal of roles, populations are kept in check and the balance of nature maintained.

Using Food Chain Information in Fishing

A study of food chains quickly demonstrates that waters rich in producers will generate more consumers, particularly those of higher orders. As a primary step, anglers should begin to analyse the water they fish, attempting, at least superficially, to determine if an abundance of plants, including algae, exists and if they can observe significant quantities of bait.

Without a firm base, the number of predators at the top will be severely limited. Experienced anglers always feel more comfortable working water that shows living things, even if those animals are not the fish they plan to catch. If, for example, you overturn a number of rocks at the side of a river or impoundment, and find crayfish or shrimp, you can almost bet that there will be yellowbelly or silver perch present. In a trout stream, insect larvae attached to rocks, is an indication that the water generates plenty of food for trout.

On the negative side, water that is stagnant, polluted, or otherwise shows signs of oxygen depletion will hold a much smaller crop of fish. The key to catching fish lies in fishing productive waters. Even before one begins to think about technique, it is imperative to select waters where there is a strong food chain and fish populations are close to carrying capacity.

Using food chains as a guide, an angler begins to understand the types of food a given species prefers. Usually, the diet covers a relatively broad base but there are certainly primary targets. Whether one relies on natural or artificial bait, the idea centres on giving the fish what they want or what they would find naturally in those waters. In terms of trout feeding on insects, this is called "matching the hatch", but the concept goes far beyond that. If shiners are prevalent in a body of water, they make excellent bait. The same approach goes for sardines, pilchards, or other baitfish in salt water. Find out what fish are feeding on and then try to present the same thing or a reasonable imitation in the form of an artificial bait.

Since most angling effort is directed toward at least second order carnivores, how they find food is important. Those that ambush their prey will usually lie close to some form of cover or use their own disruptive colouration to help them blend into the terrain. They wait motionless for their prey to approach and then launch a very swift and accurate attack. Knowing this, one must make sure the bait or lure is worked very close to the area where these fish are most apt to lie. They will not chase their prey for great distances. If the offering does not land close enough, there is an excellent chance it will be ignored.

Fish in moving water maintain a very precise lie. This is particularly true of trout and Murray cod for example. When feeding on drift carried by the moving water, they seldom move more than 30 to 60 centimetres in either lateral direction to take their prey. If the presentation does not drift naturally through this zone, the chances of a response from the fish are minimal.

The heart of predator/prey relationships focuses on the fact the predators select and attack one specific victim at a time and that they prefer a victim that is isolated, disabled, or different-looking. A baitfish tethered to a hook and allowed to swim among a school of the same bait will be ferreted out and struck by a predator. The fact that the prey in question behaves differently is all it takes.

If that baitfish is kept near the school, but on the fringes, there is an even better chance that a predator will find it. Stragglers are the first to be picked off. It's no different with artificial lures. Assuming the cast is made into a school of baitfish, the retrieve will draw the lure away from the pack, enabling any larger fish nearby to isolate and attack it. One trick that works well with schools of baitfish is to use heavier lures that will sink beneath the prey to the area where predators are most likely to be. Remember that they prefer to lurk beneath their victims and strike upward rather than downward. Most attacks start either horizontally or toward the surface, rather than toward the bottom.

The successful angler uses all of the information in his possession to increase his chances. By understanding the ecological facets of the game and applying the basics of the food chain, one can select the best waters and then present a bait or lure in the areas most likely to hold the quarry.

LESSON 23

AQUATIC COMMUNITIES – EXAMPLES AND ADAPTIONS

Return to Contents

LESSON 23

Aquatic Communities – Examples and Adaptions

Lesson Objectives

Following this lesson students will:

1. Understand different aquatic communities.

2. Know that animals live at nearly all water levels.

3. Be able to compare aquatic communities in different types of water.

4. Know how organisms react to specific habitat.

5. Understand the food chain.

6. Know why each aquatic community contains its own species of fish.

Materials for the Lesson

1. Overhead transparencies and photocopies of the graphics in the appendix

TEACHING STRATEGY

Lesson Content Outline

I. Ponds and Lakes
A. Surface
B. Open Water-Pelagic
C. Shoreline-Littoral
D. Bottom-Benthic

II. Rivers and Streams
A. Shore Zones
B. Bottom

C. Riffle Pools

III. Estuaries
Marshes and Wetlands

V. Oceans
A. Inter-Tidal
B. Coastal Waters
C. Open Ocean

Classroom Procedure
Based upon your geographic location, you may choose to teach all or just a portion of this lesson. Also, you may again wish to invite a fisheries biologist or science teacher to help with the content of the lesson.
1. Introduce students to the lesson objectives

2. Define the terms, "population" and "community". A population is a group of organisms of the same species with similar ecological requirements. A community is a number of different populations living in a prescribed area of physical habitat. Indicate that these will be discussed in relation to a number of different types of aquatic environments.

3. Briefly review the concepts of the food chain and energy flow. Both are relevant to the content of this lesson.

4. Discuss ponds and lakes and the zones where aquatic life will be found. These include:
A. Surface
B. Open Water
C. Shoreline
D. Bottom

Discuss these zones**,** how fish feed, what species most often utilize these zones, what types of foods are available, what types of plants (if any) will be found in each, and what types of organisms other than fish will be found in each area or zone. The food chain and energy flow can also be discussed in relation to each zone as well as what this information can mean to anglers.

5. Discuss the unique features of rivers and streams - their constant unidirectional flow. Ask students to compare this type of aquatic environment to that of dams and impoundments. Discuss what influence rainfall, drought, and water releases have on this type of aquatic environment and discuss the zones or areas of rivers and streams, including:
A. Shore Zones
B. The Bottom
C. Riffle Pools.

Compare life in these areas to life in lakes and ponds, how and what fish eat, and where fish would be found in each zone. Ask why it is important for anglers to know this information.

6. Discuss the unique features of an estuary and ask if students can name any in your area. These mixing zones of fresh and salt water host a wide variety of fish and other life, including barnacles in areas of higher salinity. Ask students to compare this aquatic environment to the ones previously considered.

7. Marshes and wetlands have specific characteristics and important functions. Discuss these and include their importance as breeding and feeding grounds, the production of nutrients, and some of their basic characteristics in terms of plant life and soils.

8. Oceans cover nearly three-quarters of the earth's surface and host an amazing variety of plant and animal life. Discuss these in relation to the:

A. Intertidal Zone
B. Coastal Waters
C. Open Ocean

INTRODUCTION

By definition, a population is a group of organisms of the same species with similar ecological requirements. A community is an assemblage of varied populations living in a prescribed area or physical habitat. All of these organisms depend on non-living portions of the environment for survival. There is a delicate balance, with each species restricted by one or more limiting factors.

Successful recreational angling depends as much on mental exercise as physical activity. Understanding an aquatic environment and reactions of a species is vital in determining where fish will be and how they will respond. For example, insect life is a major food source for stream trout. Absence of necessary insect species affects the size of the fish and forces the trout to turn to other food sources.

In this lesson, students will study aquatic habitats and learn how different species react. The food chain is placed in a practical perspective, based on the type of water and specific areas within that water.

NARRATIVE

Each type of water has its own characteristics. Organisms have the ability to tolerate changes, or perish. Water levels constantly change; oxygen content varies; and temperatures fluctuate. Competition for existing habitat is keen, often involving several species battling for the same food or space. The processes of natural selection and adaptation determine which species will survive and which will not.

A population is a group of organisms of a single species in the same area at the same time. These organisms depend on the non-living portion of the environment for their survival, interacting with it on a continuing basis. A community is several populations living in a prescribed area or physical habitat. A major community is somewhat independent from other communities while a minor community usually has a close relationship to other communities. A log in a dam or impoundment may form a minor community, but the dam or impoundment, itself, is a major community. The ocean is also a major community and requires only energy from the sun. However, there are numerous minor communities in an ocean.

A community has an organisation or chain. Energy flows through the food chain from the lowest level to the highest. Over time, the species in a community may change, but the replacements may perform the same functions. Producers (consumers that prey on one another), scavengers, and decomposers all exist in an aquatic community.

Within a given habitat, each species has its own niche. The resource is spread among many organisms. Crayfish live on the bottom, feeding on insects and small fish. The freshwater eel tailed catfish also lives near the bottom but it is more of a scavenger. Mullet feed on plankton and barramundi feast on mullet.

Dams and Impoundments

Dams and impoundments are considered to be standing waters. There may be a slight current moving through an impoundment, but compared to those in a stream or river, currents in a dam or impoundment are negligible.

Farm dams are often designed to be catch basins, tailored to hold runoff from rains. Larger impoundments are used to store water for generating electricity, as a source of water for irrigation, or as drinking water for cities, and may have similar characteristics in terms of water levels. Significant draw downs may occur at certain times of the year when they are utilised to supply water during periods of reduced rainfall. Drastic draw downs may tamper with spawning, destroy shore line vegetation, and even trap organisms in pools that dry up. To survive, fish must adjust to these changing conditions and move to areas that satisfy their needs, or die.

Surface

Organisms that live in the narrow zone at the surface of the water are known as neuston. A film forms on top of the water and serves as a "barrier" with the air. The molecules in this film are extremely cohesive and form a base for a variety of organisms. Some remain on the underside of the film, suspending from it while others are limited to the top portion. Looking closely at the surface, one can see very small animals that look like dust. During periods of abundance, so many of these tiny creatures are on the surface that it looks as if the water is coated.

To certain species of fish, the surface becomes a feeding zone. Insects may fall on the surface and become fair game for trout, Australian bass and saratoga. Small baitfish sometimes hover just under the surface film where they appear as silhouettes to larger fish below. A frog swimming across the surface of the water may become a target for a larger predator.

Fish are extremely alert to feeding opportunities at the surface and respond to the sounds made by other fish breaking water, to engulf a prey. Anything moving across the water's surface creates some type of disturbance guaranteed to attract attention. If the water is relatively shallow and the sun is shining, the shadow of anything on the surface generally appears on the bottom. This, too, will telegraph a message to fish that something is happening above them.

Open Water - Pelagic

Plankton is the general term applied to very small organisms moved by wind or current. Animals are known as "zooplankton" and plants are called "phytoplankton". Algae make up the tiniest forms of phytoplankton and become food for forms of zooplankton including protozoans, rotifers, and miniature crustacea.

Distribution of plankton is not uniform. Sheltered areas of a dam or impoundment may contain heavier concentrations referred to as a "bloom" that changes the colour of the surface water. Heavy concentrations may occur in open waters where currents cause convergence. Water has to be relatively stilled for plankton to exist, and almost all plankton has the ability to float. Small numbers of plankton are carried in streams but are not produced in fast-moving streams, rather in standing water such as a dam or impoundment.

Baitfish roam open areas of a lake or the ocean, feeding on plankton. Predators follow the baitfish and devour them, thus continuing the food chain. Fish that spend a significant amount of time in open water are known as pelagic species. Marlin, sailfish, mackerel, and bluefin tuna are typical ocean open water predators as well as silver perch and yellowbelly in the rivers and impoundments. They all prefer the open water and follow the food supply.

Open water areas can be important to an angler, particularly when there is an abundance of baitfish. Predators tend to lurk below their victims, forcing the smaller fish toward the surface. Hence, signs of baitfish on top of the water can be a tip off to anglers and is usually worthy of investigation.

When larger fish feed on bait, it is often possible to see their splashes or boils. Predators may take their prey just under the surface and turn downward immediately after striking their victim. The rapid turn and strong tailbeat sends an easily spotted swirl to the surface. Frantic movement of bait is another tip off that larger fish are shadowing the school. Learning to read these signals is an important facet of finding fish in open water.

Shoreline - Littoral

The shallow area along a shoreline is known as the littoral zone and is critical to the production of rooted plants. In many cases, light penetrates the water all the way to the bottom, making it possible for various plants to grow and thrive. Emergent plants are found closest to shore. These include bullrushes, various marsh grasses and plants that grow in damp spots and often extend into the shallow portion of a dam or an impoundment.

Floating-leaved plants, such as water hyacinth, water lilies and weeds form the next group. They grow in water to about 3 metres deep and can be recognised by their slender, flexible stems and leaves that float on the surface. Fields of water hyacinth and water lilies usually mean that the area is of relatively uniform depth and is probably less than 3 metres deep.

Submerged or floating plants form the third group. The submerged species do not require contact with the atmosphere. They have the ability to absorb carbon dioxide directly from the water and give off oxygen. Waterweeds, are among the submerged plants. Water hyacinth, watercress and duckweed float and survive on the surface without a root structure. Very fertile dams and impoundments often have large areas covered with this greenery, making fishing difficult.

All of these plants are vital to the production of oxygen, but excessive concentrations make fishing extremely difficult. Dead and decaying plant life also use up considerable oxygen when the decomposers do their job.

From a fishing standpoint, the littoral zone becomes a haven for baitfish as well as for predators. Small fish use shallow water and the abundance of vegetation for protection. This is also the area where the majority of logs and other types of cover are found. The food supply lingers in this part of the lake or pond and northern pike often wait in ambush among the weeds while Australian bass and saratoga will station themselves among the structures. Schools of fingerlings also remain close to shore where they can feed and avoid predation.

Big fish frequently invade the littoral zone during periods of low light levels. Early morning and evening forays for food are commonplace and are usually the best times to fish the shallows for trophy fish.

Bottom-Benthic

The bottom of any body of water becomes a haven for a variety of organisms. Lake bottoms are divided into the littoral zone and the profundal, a deep-water zone beyond the littoral. Although rooted plants are not considered part of the benthos, they may abound in the littoral part of a lake or pond. This area is characterised by a high oxygen content and low carbon dioxide.

The profundal represents the deep part of the lake and refers to waters usually found in the hypolimnion (below the thermocline) where light levels are weak, oxygen is low, and carbon dioxide relatively high.

Starting at the base of the food chain, decomposers are on the bottom and dead matter filters down. In nutrient-rich lakes, complete decomposition seldom occurs. It is important to remember that the process of decomposition uses oxygen and the area below the thermocline may have a minimum amount of this vital element during periods of the year.

Other animals hold near or on the bottom and feed on the decomposers. These include larval forms of insects (dragon fly nymphs, for example), several types of worms, crayfish and certain species of fish. These animals are essential elements of the food chain. Larger predators attack the consumers and the food chain continues. The bottom holds a great many fish because it affords excellent hiding, a minimum of current, and more stable temperatures than the surface. In many cases, fish will hover just off the bottom.

To the angler, the type of bottom can be extremely important. Frequently, fish will stay on the edge where the bottom changes from sand to pebble, from mud to sand, and so forth. Any object on the bottom affords cover for a variety of animals. Rocks, logs, natural rises or pockets, and anything that sticks up from the bottom often appeal to fish. As a general rule, the majority of fish in a lake or pond spend a significant part of the time in the lower 10% of the water column.

Rivers and Streams

The unique feature of rivers and streams is their constant unidirectional flow. No other type of water can make this claim. Flowing waters are constantly changing. The topography and the amount of rain determine how much a river or stream fluctuates. Current can increase very quickly. Without a steady inflow of water upstream, levels begin to drop quite quickly, During drier times of the year, smaller streams and rivers break down into a series of pools. Riffles and rapids become gentle compared to their full potential. During major periods of flow, rushing water carries chunks of logs, and rocks. These have a wrecking effect and often change portions of the river. At the same time, smaller particles are carried in a suspended state and are deposited in various areas as the flow changes, forming sandbars and other shallow areas.

Rapid transformations of water flow challenge the ability of various organisms to survive. The animals must adapt to fluctuating water levels and dramatic changes in current.

Shore Zones

The main force of a current is in the middle where water depth is the greatest. This changes when there is a relatively sharp bend. Here the primary force moves to the outside edge until the streambed straightens again.

The area closest to the banks (except where a sharp bend occurs) has the least amount of current. That is an important factor in determining the types of flora and fauna inhabiting that area. This area might suddenly find itself high and dry when stream levels drop. Organisms that can swim or move about have no problem in this zone, but those that attach themselves to a stationary object are in trouble if the water level changes.

In areas where the water flow is reduced, aquatic vegetation often grows near the banks. However, each type of habitat serves as a haven for specific organisms that have a particular niche in which they survive.

Anglers believe that most of the fish are in the deeper parts of moving water. That is not necessarily true. Trout, for example, may station themselves over a gravel bar close to shore where the typical fisher enters the water. Fish, alert to unusual sights and sounds, flee long before the angler reaches the bank. It is precisely this type of experience that makes the enthusiast believe that all of the fish are in deeper and swifter water.

Bottom

The bottom habitat in flowing water changes more often than that in still water. Fluctuating flow conditions create currents that may cover certain areas with silt or other debris while simultaneously scouring out pockets, cleaning gravel bottoms and providing depressions and other hiding places for a variety of organisms.

In flowing water, there is less current near the bottom than at the surface or mid-depth. For this reason, most fish position themselves with their bellies almost touching the bottom. Any indentation or depression has even less current than the surrounding water. Organisms, including fish, take advantage of these spots to conserve energy. A very short distance away the current may be rushing, but in that little haven, life is comfortable.

Plankton does not usually exist in fast moving water but can be carried through such water from other sources. Slow flowing rivers and very slow sections of a stream may have some plankton. Almost any tiny organism living in a stream has some form of appendage to hold it in place. The greatest problem for these miniature food sources is losing their grip on bottom structure and being swept away by the current.

Algae often grow attached to stones and rocks, and some rely on secretions or holdfast cells. One-celled algae, called "diatoms", form a coating on rocks, making them exceptionally slippery. That slickness reflects the bottom of the food chain. Snails use their feet to anchor to the rocks in order to feed on the algae. Certain animals thrive near a current. The larvae of the Caddis fly take advantage of the flow to filter out food particles. Mayflies require running water as do stoneflies, dobson flies, alder flies, and others. Animals live under rocks or they tenaciously cling to the surface.

The majority of fish in a stream face into the flow of water and wait for food to come to them. They are able to watch the water column from the bottom to the surface. In freshwater streams it is not unusual to see a trout feast on a nymph (a bottom dwelling insect) one minute and on a floating insect the next.

Luderick and bream prefer cold, moving water and tend to take up stations behind structures where the flow is reduced but where they can move 30 centimetres or so to either side to take whatever food is coming by. During periods of low light and at night, these fish often invade the shallows where the current is reduced and where small fish or cabbage weed may be holding.

It is important to understand that fish in current seldom move very far for food. An angler must present the bait or lure accurately or it will be carried down-stream without a response. Fish feeding in a current have only a second or two to decide whether or not to take an offering.

Scientific observations have shown that most stream fish feed constantly and take advantage of whatever food filters their way. Specialisation occurs only when there is an abundance of one type of food such as the hatch of a particular insect.

Riffle Pool Concepts.

As one moves up or down a stream, habitat changes constantly, varying from a series of riffles and/or rapids to smooth, fast flowing areas and pools. Water in riffles is well oxygenated and often forms vertical currents as well as the standard horizontal flow. There is a tumbling action that affects life in that area. Usually rocks, logs, or other debris combined with a steeper gradient cause the riffle. Pools can also be well oxygenated and occur where there is a shallower gradient. Some of our smallest native fish, live in the riffles, and are only 1.5cm-2.5cm long.

The severity of a riffle depends on the gradients and substrate and the seasonal flow of water or amount of rain upstream. In the spring, there is usually a strong flow, but by mid-summer, many riffles are a shadow of what they once were. Just above the riffle, the water is often relatively slow moving with a dead area caused by an area of little or no grade. Fish frequently hold in these locations.

Murray cod prefer locations near fast water and take up residence alongside riffles, but they are seldom in the main current. They can be found on the edges and down toward the tail of the run as it starts to smooth out.

The tail end of a pool ranks high as a feeding area for fish because the water is somewhat slower and tends to flatten out. Depth decreases in this area due to siltation. Murray cod and silver perch have a habit of holding at the tail of the pool and chasing whatever offerings come by. Whiting and bream move onto the shallow banks to feed as the tide rises.

A common misconception among anglers is that their quarry moves into the tail of the pool or the shallow salt water weed banks during the evening hours. If one were to observe these fish undetected, it is possible that they have been there all day long. The problem lies in being able to approach the fish in the shallow areas. They may detect the angler and disappear before the first cast, leading people to believe they are there only early or late in the day. However, when light levels are low, it is easier to sneak up on the fish.

Estuaries

Estuaries are a mixing zone where fresh and salt water blend. At least one fresh water source enters the head of an estuary. A river may be tidal (influenced by tides) for several miles upstream, but is primarily fresh water. In an estuary, the closer to the ocean, the more marine the conditions become. As a rule, fresh or brackish water remains near the surface and the more saline water closer to the bottom. Tides tend to flush an estuary, bringing in sea water and carrying out some of the fresh water.

Salinity becomes the primary limiting factor affecting organisms living in an estuary. Fish and other mobile animals have the ability to work in and out with the tide and remain in water of relative constant salinity. That is not possible for organisms anchored in one spot. They must be able to withstand major changes in salinity. Some have the ability to pull back into their shells or to burrow as a protective device. The disadvantage is that they have a limited amount of time in which to feed while they wait for tolerable conditions.

Rivers carry suspended particles, which usually drop once the flow slows in the estuary. The upper reaches of many estuaries feature a deep channel where the river cuts through with shallow flats on either side. Frequently, these flats have a soft bottom resulting from the buildup of sediment carried by the river.

Pollutants can be carried into an estuary and sewage and industrial wastes have caused changes in the typical flora and fauna. There, in shallow areas, oxygen depletion may occur from bacteria feeding on the sewage. This also limits the life that can exist.

Estuaries are fragile zones where changes can be very dramatic. Animals that require a reasonable amount of salinity do not go beyond a very pronounced, imaginary line. Fish that demand salt water limit their forays into the parts of the estuary that are less saline.

For the fisher, an estuary offers exciting potential. Frequently, both fresh and salt water species take advantage of the mixing zone. It is here that the young of many species battle for survival and predators roam freely, simply because the food supply is present.

Finding fish requires one to check on the salinity, at least in a superficial way. Experience quickly teaches which fish venture farther into fresh water or remain in the salt. Looking for other forms of life serves as an important clue. The presence of barnacles, for example, indicates more salinity. Their absence shows that there is an abundance of fresh water.

A number of species spend most of their lives in salt water but ascend fresh water rivers to spawn. The Australian bass and mangrove jack are examples. These fish are said to be anadromous, meaning that they live in salt water but ascend fresh water rivers to spawn. Salinity is critical to the spawn and the eggs must be deposited where the right conditions exist.

Marshes and Wetlands

Tidal marshes and mangrove forests are critical to production of salt water game fish and forage species. Other wetlands serve the same function in fresh water. Juvenile fish seek shallow water where it is more difficult for predators to reach them, and certain species will move into shallow water to spawn. Deeper wetlands become a feeding ground for a variety of predators. Within these wetlands, the food chain that flourishes on all levels is vital to the survival of many species.

Marshes contain soft-stemmed, herbaceous plants known as "emergents" because they grow with part of their stems under water. Water depths may range from a few centimetres to about one metre. Among the plants found in a marsh are bullrushes, water lilies, and pondweeds. By contrast, trees and shrubs dominate a swamp. These could be hardwoods or evergreens. Soils in both marshes and swamps are extremely organic with a black muck usually found on the bottom.

Wetlands are among the richest lands anywhere in terms of production. A bullrush marsh, for example, may yield 12 tonnes of biomass for every hectare while a sedge marsh produces about 4 tonnes. Some of this productivity can be traced to the fluctuations of water level. The fluctuations carry and expose nutrients and also insure adequate oxygen. Where periodic flooding occurs, the wetlands are richer than those with somewhat stagnant water. Saltwater wetlands benefit from the tidal cycle in much the same way.

Oceans

Almost three-quarters of the earth's surface is covered by oceans, and organisms living in the sea differ considerably from those in fresh water. Almost all ocean plant life is algae including the giant Pacific kelp and the hectares of sargassum weed that coat the surface of tropical seas. Scientists report that algae, in one form or another, have not left any suitable habitat unoccupied. Phytoplankton require energy from the sun to reproduce and flourish. This occurs year around in the tropics but only during the summer months toward the poles. Complex groups of zooplankton live in the sea and the food chain progresses upward from there.

Fish are able to survive from the greatest depths in the ocean to the shallow, intertidal zone. Temperature and water depth, limit the distribution of each species.

Intertidal Zone

The intertidal zone represents the interface between land and water. In the most common circumstances, the flooding tide covers an area. Then, that same zone is exposed to the air during the ebb tide. Complications occur during periods of spring tides when the water pushes farther shoreward or in areas where waves lap over an area, cover it with water and then fall back to the sea. Many life forms in this zone have the ability to burrow and survive. Some can no longer exist totally submerged or totally in air.

Salinity may also change in the shallowest parts of the intertidal zone, particularly after a rain or following fresh water incursion from rivers and streams. Bottom forms vary from rocky strata to sand and even mud. All serve various organisms. The food chain is elaborate and complex, with various species battling for space and a chance to colonise.

Game fish predators raid this prime habitat. The bonefish is a master at following the tide inland, feasting on crustacea and other animals coming out of their burrows as water floods the region. Big sharks prowl flats with their bellies scraping bottom and their dorsal fins and backs out of the water. Many other species of highly prized table fish also work the tides and look for food in the intertidal zone. Flathead lie in depressions close to a sandy beach to ambush baitfish. These predators are constantly aware of water depth and know when to move seaward. On a shallow flat, one can actually see fish falling back into deeper channels just ahead of the receding water level.

Although all of these predators feel more comfortable in deeper water, they probe this shallow intertidal zone because it holds an abundance of food including mussels, yabbies, worms and crabs.

Coastal Waters

Inshore waters are seldom as clear as the open ocean; therefore phytoplankton production is restricted to the uppermost levels. Production continues throughout the year in tropical locations, but may be seasonally limited in more frigid climes where the sun angle is exceptionally low during the winter.

Temperature also affects the variety of organisms in the water. The warmer the average water temperature, the more forms of life it supports. There are fewer species of animals in colder seas. One explanation is that tropical animals are more highly specialised and occupy a much narrower niche in the environment.

The coral reef is a phenomenon of the shallow, tropical sea. Reef-building corals cannot survive without a minimum water temperature of at least 20ºC. The water must be relatively clear and less than 100 metres in depth. There are other species of coral that grow much deeper, but they do not build reefs. The seaward side of a reef usually falls off into deep water rather quickly.

Ocean bottom may feature sections of exposed rock, but for the most part, it is composed of sediment or sand. Coarser grained sediments occur closer to land. The farther offshore, the finer the sediment. The size of sediment grains may seem inconsequential, but as part of the food chain, the larger the grain, the bigger the organisms that utilise it. It also means that burrowing animals must be of greater size.

Fish occupy all levels of inshore waters, with the largest number closest to the bottom. Pelagic species work the mid-depths and even the surface, moving wherever the bait happens to be. Coastal waters receive the heaviest fishing pressure, both by recreational and commercial fishers. They are exceptionally rich in a variety of foods that support hundreds of species of game and food fish.

From the standpoint of adaptation, many species orient to some form of structure, such as a coral reef, rocks, or other obstructions along the bottom. Certain predators strike from ambush among the cover, while others roam freely, searching for an easy meal.

Depending on geographic location, anglers have dozens of species to pursue. The popularity of these inshore waters also stems from the fact that they are easy to reach aboard relatively small boats or from the beachfront. One can almost predict the lifestyle of a species simply by looking at its physical characteristics. Fast swimmers that probe and prowl have forked tails and streamlined bodies. Those creatures that make their home in the rocks or around reefs are chunkier and have broad tails for manoeuvrability.

Open Ocean

The inland visitor who sees the ocean for the first time views it somewhat like a desert - a broad expanse that looks identical in every direction. Those who survive on deserts see marked differences in the terrain. Open ocean anglers read the water with similar skill and understanding.

It is worth noting that every part of the sea explored by man has produced some form of life regardless of depth, water temperature, or amount of light. From a practical standpoint, however, anglers are concerned only with the top portion of the ocean.
Organisms as tiny as plankton occur in open water. Upwellings bring nutrient-rich waters to the surface where the sun causes more plankton to bloom. Zooplankton feed on the plankton and baitfish feed on them. These are a source of food for dolphins, tuna, marlins, swordfish, sharks, and other denizens of the deep.

The flying fish, for example, is an open water species of bait. Dolphin feast on flying fish and marlin attack small dolphin. Nothing is safe in big open water. Sargassum weed produces its own ecosystem. The tiny balls are really floats that keep this large algae on the surface. There is a sargassum crab that lives among the weed and several varieties of small fish seek sanctuary in that habitat.

Most fish species that live in deep water grow at a phenomenal rate, at least during the early years. A marlin grows from the size of a pinhead to 5 kilograms in 12 weeks. Recreational angling takes place within the confines of the continental shelf, out to about 350 kilometres from the shore. Researchers know that several species of game fish cross oceans, but the fishing pressure is limited to places that boats can reach with relative ease and safety.

Open water fishing is a speciality in which anglers seek prime game fish. To reach these fish, a large sport fishing boat, or at least one with a centre console with plenty of power to get out and back, must be utilised.

Countless species have evolved over eons of time and each shares the resource with others. To survive they specialise. Too much specialisation might spell disaster, so each animal arrives at the right balance through evolution. The key lies in adaptation to the environment and ecosystem.

Beaches

The beaches, which surround the Australian coast, are an important factor in the survival of fish and other marine creatures. Beaches support a wide range of shellfish, which are the major food source for the fishery.

In particular the prevailing north east and south east winds are the most common to the eastern coast line. Of these the south east impacts on the surf beaches for 80% of the year, continually moving sand deposits and creating new surf gutters where the coast line is exposed to the Coral Sea. At various time of the year cold currents travel from the south bringing plankton and baitfish to the northern waters. Fish such as mullet, tailor, mulloway, follow the baitfish which are primarily frogmouth and blue pilchards.

Where the beach is exposed to the Coral Sea, the sand granules are fine and yellow to white in appearance. The beach sands protected by the Great Barrier Reef are coarse, and composed of coral and sedimentary rocks, ground down by the movement of the water.

Both types of sand hold a wide range of invertebrates. The beach worm is one of the common baits sought by the beach angler. These are caught by hand using a piece of bait to entice the worm to expose its head. Then quickly grabbing it with the fingers, one can draw it from the sand. Another common bait is the eugarie or pippie, which buries in the sand below the high water mark. By digging with the feet and using the action of the waves, one can dislodge it, causing the eugarie to be washed down the beach with the waves. Then it can be easily picked up and put in the bait holder.

The action of the south east winds creates a current moving in a northerly direction along the coastline. Beach formations that occur where the current makes deep gutters, complete with an entry and exit, are important to the ecology of the open beach.. These gutters are important for fish as the continual movement of the current or rip in the gutter allows fish to feed on the worms and eugarie. Baitfish seek refuge in these gutters on a falling tide but are in danger when the tide is making. Larger fish such as the mulloway or shark seeks out these gutters because the baitfish are confined and can be easily caught. At various times of the year the media have shown graphic pictures of sharks feeding on pilchards in surf beach gutters, likewise sharks feeding on spawning tailor at Fraser Island.

The beaches in the northern waters of the Queensland coastline also support a wide variety of bait. Eugarie do not survive in the warmer waters but there is a greater population of baitfish. These baitfish are caught with cast or bait nets and are very popular on the neighbouring reefs.

LESSON 24

WATER AS ENVIRONMENT

Return to Contents

LESSON 24

Water as Environment

Lesson Objectives

Following this lesson students will:

1 Understand basic physical and chemical properties of water.

2. Understand the importance of water quality in sustaining fish populations.

3. Learn the basic relationships of fish populations to the water in which they live.

4. Be able to relate the various foods available for fish to the different types of water in which they are found.

5. Comprehend the steps in the water cycle.

6. Be able to discuss the thermal properties of water and density in relation to temperature.

7. Be aware of how human culture affects water in terms of use, pollution, and management.

Materials for the Lesson

1. Eye dropper, glass bowl, small piece of screen.

2. A length of string.

3. Two water glasses and several sugar cubes.

4. Pan, and a thermometer that can be used in boiling water.

5. Photocopies and overhead transparencies prepared from graphics in the appendix.

6. A chart showing the spectrum of colours, if possible.

7. Small container of dirt.

TEACHING STRATEGY

Lesson Content Outline	Classroom Procedure
I. Introduction	The content of this lesson can be expanded to several class meetings and must be adjusted to meet the needs and abilities of your students. Be selective in the activities and demonstrations that you use, based on these factors. Several resource people could also assist for selected topics on water use, pollution, etc. 1. Begin with a discussion of the importance of water in our everyday lives. Stress that it is a limited resource and for that reason we must be very careful. The demand for clean water is increasing. Ask students how water is important in their lives and then ask them how important it must be to fish. Water is, in a sense, their atmosphere and the quality of their environment will affect their ability to survive and prosper. 2. Two hydrogen atoms and one oxygen atom combine as a molecule to form water. Within a short temperature range, water can be a liquid, solid, or a gas. No other substance can do that within the span of 100°C.
II. The Nature of Water A. Physical and Chemical Features 1.Surface Tension	3. Ask students if they have seen items floating on the surface of water that seemingly should not be there. This introduces the concept of surface tension. Water has a very high surface tension and small organisms often live on top of this film, or just beneath it. This property can be demonstrated by using an eye dropper to show surface tension by allowing a drop of water to cling to the end. Also, this can be seen around the edges of a glass or in a bowl of water with a small piece of screen placed on top.
2.Capillary Action	4. Capillary action is another physical property of water. This is the ability of a liquid to climb against the pull of gravity. Place a string in a bowl of water and drape the string over the side of the bowl. Shortly, the water will begin to drip onto the table. This property helps water to filter upward through the roots of plants.
3.Density	5. Explain that similar to other liquids, water becomes denser as it cools. This continues until it reaches a temperature of 4^{o} C, where it is at its heaviest. Then, it begins to become less dense and lighter, and expands in the process. Therefore, water colder that 4^{o} C floats upward toward the surface, and as it freezes adds about nine percent to its volume, enabling ice to float. Illustrate by dropping an ice cube into a bowl of water and ask students if they have ever seen the result of water expanding as it freezes. Examples would be broken containers, etc. Explain that water is the only liquid that becomes less dense when it freezes. If it acted as other liquids, bodies of water would freeze from the bottom up, killing fish and other aquatic life.

6. Following on the principle in #5 discuss what happens in the Spring when the ice melts. The water on top becomes warmer than the water at the bottom of the lake. As its temperature reaches above 19°C, it becomes less dense and the cooler water from below moves to the top forcing the less dense top water to the bottom. This phenomenon, sometimes called "turn over" occurs both in the Spring and the Autumn seasons of the year.

4.Viscosity
5.Buoyancy

7. To demonstrate the viscosity of water (e.g. thickness/thinness), if you are able to heat water, pour hot or near boiling water into a sink and then follow with cold water. Have the students note that the hot water splashed more than the cold water. This property of water offers resistance to fish. However, there is a tradeoff. Bodies in water seem to grow lighter. A force equal to the weight of the displaced body buoys up the body. This same buoyancy principle permits boats to float. They displace more water weight than the weight of the boat and its contents. This property also permits fish to swim easily through water.

6.Water Stratification

8. Emphasise that during the Summer, between Spring and Autumn mixing periods, lakes, impoundments, and dams form three distinct layers of water. A warm surface layer (epilimnion), a cold bottom layer (hypolimnion), and a middle layer known as the thermocline; the thermocline being the area of rapid temperature change. As oxygen is used up in the hypolimnion, fish tend to move toward the thermocline in the summer months.

B. Universal Solvent

9. Water can hold an incredible number of substances in solution and is often called a universal solvent. As it runs over the surface or trickles through the ground it dissolves some of these substances. Water does not change them, thus making them available to all types of aquatic organisms. In this absorption, water levels remain constant. To demonstrate this principle, take two glasses with the same water level. Into one, drop several cubes of sugar. Note that as they are absorbed by the water, the level does not change.

C. Transparency and
Absorption of Colour

10. Explain that water absorbs light. Even when water is clear, almost all light is filtered out within the first 9 metres. Ask students what this means for plant growth in clear or clouded water. Where will it be found? Along with darkness, loss of colour also occurs. Colours with longer wavelengths are absorbed more quickly and the red end of the spectrum disappears in less than 9 metres when the water is perfectly clear. Blues and greens are the slowest to be absorbed and can be seen the farthest. Fluorescent colours retain their shades deeper than standard colour.

II. The Water Cycle
A. Natural Movements

11. Using the photocopied handouts and an overhead transparency, discuss the water cycle. Include here that water is a finite resource.

B. Impact of Human Culture 1. Water Use 2. Water Pollution 3. Water Management C. Our Water Inventory – Quality and Quantity	12. Lead a discussion concerning water use, water pollution and water management. Ask the students for examples, both good and bad in their area, of the impact of human culture on water resources. Ask further for them to suggest ideas that they could implement either individually or as a class to improve a particular situation in the local area. Stress that water quality affects our lives and will more so in the future, and that we all have a responsibility to care for this scarce resource. As an example of human impact and as a result of construction or poor farming practice, which allows erosion and runoff into streams, etc., take a bowl of water and pour in some of the silt or dirt. Mix it well and then pour this into another larger bowl of clear water. Notice how the silt permeates and spreads in the larger bowl. Expand the discussion to the effect that this can have on lakes, streams, and other bodies of local water.
III. How Water Affects All Aspects of Fish Populations A.Water Quality,Type of Fish and Quality of Populations	13. Discuss that fish enjoy and thrive in a good environment, just as people do. Where food is plentiful, the water quality is good, and cover exists, fish populations will thrive. The opposite occurs in a poor environment. Lead a discussion about the local area and the fish that are available in certain types of water. Talk about why they are there, what would happen if the water quality changed, and what each student can do to preserve the water resource
B.Water Colour and Lure Selection	14. Discuss, or have a resource person lead a discussion on how water colour can affect choices in colours of lures. Talk about locally popular lures and colours and the types of fish caught on them. Colour is a topic of much discussion and interest at the present time and many companies are producing lures to be utilised in waters of differing clarity. Formerly thought to be of less importance than other aspects of fishing, colour, according to current research, may be more important than previously thought.
C. Water Type and Prevalent Foods	15. Fish are opportunity feeders; they generally take advantage of whatever is available. Discuss the prevalent types of forage available for the sport fish in your vicinity. Certain types of waters support different food sources. It is important to know these for your area and to determine what the forage species are when fishing unknown waters. Imitating these can provide good result for the angler.
D. Other Considerations	16. Different species of fish prefer differing water temperatures. Assuming adequate oxygen is available, water temperature is the most important factor in determining where fish will be. Slight temperature variations in a body of water will affect fish distribution. Look for areas that are a degree or two warmer in cool weather or a little cooler in warm weather.

INTRODUCTION

Most people take water for granted. It is as close as a kitchen tap in the home or a nearby creek or river. The casual observer comprehends very little about this vital ingredient of life. However, without water, nothing could continue to live. For the angler, water represents the environment in which the angler's quarry must survive. The properties and features of this amazing liquid play a significant role in where fish are located and how they relate to their habitat.

Scientists report that water is totally recycled many times. None of it leaves the atmosphere and even the water humans drink was used many times before. Even so, that does not mean that water is evenly distributed across the earth, nor does it indicate that there won't be floods in one area and drought in another.

Knowledge of water density and how it leads to stratification of lakes is important to the angler as well as knowledge of the need for sound water management and the effects of pollution on an area rich in aquatic life. Water quality affects fish populations and individuals within the system. The condition of the water helps to determine the game fish present and the available food sources. Being able to identify and understand changes in water quality and quantity is a valuable asset when trying to locate fish or select the best places to pursue a particular species.

NARRATIVE

The Nature of Water

Water covers 70% of the earth's surface with no substance being more common. Only 3% of the water is fresh, and about three-quarters of that is locked in glaciers and icecaps. In fact, these frozen regions contain as much fresh water right now as all of the earth's rivers will carry for the next 1,000 years.

The demand for clean water continues to mushroom as the earth's population increases and as industrial processes require more and more water. In the home alone, each person uses about 280 litres of water daily for basic needs. This figure does not even include water required to produce food or that used in industrial and manufacturing sectors of the economy.

Climate in many parts of the world is controlled by the slow heating and cooling of water areas. During the winter months, oceans bring moderating temperatures to land masses while cooling breezes are produced in the summer.

The recreational use of water can be for swimming, boating, exploring the aquatic habitat, and, of course, fishing. Understanding water and its properties adds another dimension to fishing and prepares the student of the sport to be a successful fisher.

Physical and Chemical Features

Two hydrogen atoms and one oxygen atom combine as a molecule to form water. Within a relatively short temperature range, water can be a liquid, a solid, or a gas. No other substance can accomplish that within the span of 100°C. The molecules in ice are farther apart and practically motionless in comparison to the liquid state, where the molecules are much closer together and move about freely.

Surface tension is defined as the ability of a substance to stick to itself and pull itself together. Water has a very high surface tension that forms a film. Small organisms often live on top of this film or just underneath it. The tension can be so strong that, if organisms break through in either direction, they cannot get back and will dry up or drown.

The ability of a liquid to climb against the pull of gravity is called "capillarity". This is an important property that helps water filter upward through roots and other objects. Water can also dissolve other substances. In the process of absorption, water levels remain constant. This process dissolves particles from rock, soil, nutrients, chemicals, and other properties with which water comes into contact.

Thermal Properties

Heat capacity of a substance refers to the amount of heat required to produce a specific increase in temperature. With the exception of ammonia, water has a higher heat capacity than any other substance. During cooling, water gives up much more heat without a temperature drop than virtually any other substance. These thermal properties are extremely important and cause water to heat and cool more slowly than land or air.

Water freezes at 0°C and boils at 100°C. Water is constantly losing molecules from its surface with these molecules becoming a water vapour. This process is called evaporation, and an incredible amount of heat must be absorbed without a temperature change before this is possible. When 500grams of water is evaporated, it absorbs as much heat as it takes to raise the temperature of over 2500 grams of water from the freezing to the boiling point. In turning to ice, water at 0°C gives off 80 times as much heat as an equal quantity would in lowering its temperature 1°C.

From an angling standpoint, heat capacity plays an important role. Water temperature rises very slowly in the Spring and lowers over a long period in the Autumn of the year due to the property of heat absorption. Although air temperatures may be warm, the water in some areas may still he too cold for the fish species one seeks. Just the reverse could be true late in the season when air temperatures are chilly, but the water remains warm.

Density

Like other substances, the colder water gets, the greater the increase in density. This process continues until water reaches the temperature of 4°C where it is at its heaviest, weighing 31 kilograms per cubic metre. Then, a unique change takes place. Below that temperature, water begins to become less dense and lighter, expanding slightly in the process. Water colder than 4° C floats upward toward the surface. As it freezes, it adds about nine percent to its volume, enabling ice to float. If this phenomenon did not occur, ice would form on the bottom first and destroy aquatic life. There would not be enough heat in the summer to melt the ice and over a period of years, the whole water cycle would cease, as would life on earth.

Above 4°C water becomes less dense as its temperature increases. Cooler water is heavier and sinks to the bottom. Fluids transmit pressure equally in all directions. Any body completely submerged under water has equal pressure on all sides. In 30 metres of water, for example, the pressure is about 400 kilopascals. Anything that lives at that depth must be able to withstand the pressure. Therefore, fish that move from bottom to surface and back must adjust to rapid pressure changes.

The fact that water becomes lighter and less dense just before it freezes plays an important role in deep southern lakes. As the warming rays of the spring sun melt the ice and begin to heat the surface water, a change takes place. When the surface water reaches 4°C, it begins to sink to the bottom aided by wind and currents. The cold water on the bottom is displaced and pushed toward the surface where it receives more oxygen. When this occurs, the lake is said to turn over. During that period of almost uniform temperature, fish may be found at any depth.

As the sun continues to warm the water, three distinct layers form in the impoundment. The warm surface layer is called the "epilimnion”, while the colder bottom water is known as the "hypolimnion”. Depending on its depth and the work of decomposers in the water and on the bottom, the hypolimnion may become depleted of oxygen and not support fish life. However, deep oligotrophic impoundments rarely have a hypolimnion without oxygen. Between these two layers, there is a narrow belt called the "thermocline”. By definition, the thermocline exhibits rapid temperature changes of at least one-half a degree C for every 300mm of depth.

In the Autumn, surface water begins to cool first and becomes denser, sinking to the bottom. That forces the bottom layer toward the surface until the temperatures become uniform. Then, the lake turns over a second time. This is a very important mixing process, helping to restore oxygen to areas that had a minimal supply.

Thermoclines also exist in salt water estuaries and in the ocean and often determine where fish will be. Usually pelagic species remain above it. One can locate a thermocline by taking temperature readings at various depths until a rapid change is noted.

Viscosity

Because water is viscous, it offers resistance that must be overcome through the expenditure of energy by animals living in water. A trade off occurs since a body placed in water seems to grow lighter. A force equal to the weight of the displaced water buoys up the body. This also allows a fish or aquatic animal to maintain buoyancy and counters the tendency to sink. Salt water is more buoyant than fresh water.

To the human eye, all water looks the same; a thin liquid that appears very viscous regardless of temperature. Actually, water does have changing viscosity and is twice as viscous at 0°C than it is at 30°C. This can be demonstrated very simply by pouring a glass of ice water into a sink and then pouring some boiling water from a kettle into the sink. The boiling water will splash much more than the cold water, showing that the cold water is much more viscous.

Universal Solvent

Water does not dissolve everything, but it dissolves so many different compounds that it is often thought of as the closest thing to a universal solvent. It dissolves almost anything, at least to some degree, and holds an incredible number of substances in solution. Every time water runs over the surface or trickles through the ground, it dissolves some of the substances there. These are carried to oceans or inland dams or impoundments. Equally important, water does not change these substances which are vital to all forms of aquatic life, making them available to all types of organisms.

Transparency and Absorption of Colour

Water clarity controls the quality of light that penetrates this liquid medium and the depth to which it penetrates. Even under extremely clear conditions, almost all light is filtered out within the first 9 metres. It is important to recognise that light is the essential ingredient in photosynthesis, explaining why plant growth is limited to relatively shallow water. Plankton and silt particles in many bodies of water cause turbidity, which limits light penetration. Under ideal conditions, one percent of the light can penetrate into the depths. One researcher estimates that in an exceptionally clear body of water, light can be detected as deep as 180 metres. A muddy river, however, may be totally dark only a few metres below the surface.

Darkness and loss of colour increase with depth. The long wavelengths are absorbed more quickly and the red end of the spectrum disappears in less than 9 metres when the water is perfectly clear. That distance decreases with turbidity. Blues and greens have shorter wavelengths and are the slowest to be absorbed. Due to absorption of the long wave lengths of light, pigments (colours) appear differently at greater depths. The blues and greens are visible at much greater depths, while red objects appear black. Colours turn to a shade of grey and objects are seen in black and white, much as with the human eye during periods of very low visibility.

Fluorescent colours retain their shades even deeper than standard colouration. Orange, which is close to red in the spectrum, seems to retain its colour much deeper, but certainly not as deep as the blues, greens, and even yellow.

Many species of fish require at least a minimal amount of light and tend to be disoriented in total darkness. No one really knows how much light is minimal, but experiments by researchers in large aquariums where total darkness was introduced, demonstrated that some fish could not or would not tolerate the absence of light.

The Water Cycle

Oceans cover 70% of the earth's surface and become the primary factor in the water cycle. Heat from the sun causes water to evaporate and rise into the air as vapour. Every body of water gives off vapour, as do plants and crops through a process known as "transpiration”. However, since the oceans are such vast repositories, most of the vapour comes from the sea.

Clouds form and air currents push these clouds. Eventually, precipitation in the form of rain sends the water back to earth. Most of this falls on the oceans, with the remainder dropping on land. As the cycle repeats itself, all of the water returns to earth and none is lost. There is just as much water today as when the earth was formed, and there won't be any more in the future! However, new information indicates that enormous quantities of water are now entering our atmosphere from comet tails.

Natural Movements

When precipitation strikes the earth, some of it is transformed to vapour immediately through evaporation from the ground, rooftops, and puddles. A portion of the water enters creeks, brooks, streams, and rivers and eventually makes its way back to the ocean. The water absorbed by plants is returned through transpiration.

Water also seeps into the ground and moves very slowly under the surface until it reaches rivers or lakes. Some of it is channelled through springs. Underground springs release water of a relatively constant temperature that is often colder than the body of water it enters in the summer, and warmer in the winter because it is at the temperature of the earth at the depth from which it came. This water often lacks the oxygen of the surrounding water, but it does provide more comfortable temperatures for fish. The area surrounding a spring should always be explored by the alert angler.

Impacts of Human Culture

Every living thing is primarily composed of water. A human and a mouse each consist of 65% water; the elephant and an ear of corn are about 70%. Water is vital in carrying out life processes. A person dies much sooner without water than without food. Water use in the typical home has skyrocketed. It takes 12 litres to flush a toilet, 120 to 200 litres to take a bath, 20 litres per minute in a shower, 40 litres to wash dishes, and another 120 litres in an automatic clothes washer. But, more than half of the water used in Australia can be traced to industry. It takes 40 litres to make 1 litre of petrol or, beer, but 250 tonnes of water to make 1 tonne of newspaper. In addition, an enormous quantity of water is utilised in food production, especially in areas where irrigation is prevalent.

There are adequate supplies of water to handle these needs provided sources of the precious commodity are kept clean. Unfortunately, pollution taints some of the very rivers, impoundments and dams that might furnish the needed waters for expanding populations and industrial demands. However there are problems if these resources are too polluted with toxic chemicals to be used as a water supply.

In most communities, sewage contamination is the major cause of pollution. Untreated or partially treated sewage is dumped into a potential water supply. That sewage contains bacteria and viruses that could cause serious diseases in humans. Sewage also contains nutrients such as phosphorous and nitrogen that serve as fertilisers. As these substances enter a water system, they cause algae to bloom in uncontrollable quantities. When these organisms die, the decomposition can deplete the oxygen, thus killing fish. More oxygen is lost and the process of eutrophication or over fertilisation may cause most life in that water to cease. Runoffs from farmlands also cause similar problems because they put excessive quantities of nutrients into the system.

Silt carried from the land creates a different type of pollution that tends to reduce light penetration and photosynthesis. As silt falls to the bottom and begins to fill the impoundment or reservoir basin, it covers the delicate organisms living there and often destroys the eggs of fish in the process.

Toxic wastes from industry and agriculture have been a serious problem for a long time. Many of these kill fish directly and also affect the supply of oxygen in a body of water. Steps are being taken in some places to reduce and eliminate toxic wastes, but they are still a major cause of pollution in many areas. Also, some industries create a situation leading to acid rain, which causes serious water problems. Oil pollution through spills and thermal pollution through the discharges of power plants, particularly the nuclear ones, occurs. Pesticides also enter the water and often act directly, killing the eggs, fry, or juvenile stages of fish.

To counter this, many bodies of water are now being managed and efforts are being expended to eliminate sources of pollution. Those waters that are not being managed properly now probably will be safeguarded in the near future. Dams and flooding create new reservoirs as sources of water and as recreational areas where fishing, boating, and other water sports can be enjoyed. One cannot dump wastes in water, then expect to drink that water or to play in it. The key lies in controlling pollution. The more successful this nation is at that task, the better the water will be for a multitude of uses, including fishing. If pollution is not deterred, citizens could end up with inadequate supplies for basic needs.

Our Water Inventory - Quality and Quantity

There will not be any more water than there is today, so quantity really applies to quality. One has to ask whether or not there will be enough quality water to take care of everyone's needs. Water quality can be improved through careful management. When all the rhetoric on the subject has been exhausted, the bottom line still points to the need for quality water at any cost. For game fish to survive and thrive, the water quality must be fairly good. Fish are barometers of the condition of water. When they cannot survive, the water is not fit for human use.

How Water Affects All Aspects of Fish Populations

When dealing with populations, one must view the ecosystem in its entirety. Each species of fish occupies its own niche in the water environment. However, there is an interdependence among species that must not be ignored. If water conditions change and are no longer conducive to the production of forage species, game fish, which rely on that food source will suffer. Their numbers may diminish and their growth may become stunted or at least slowed.

Natural events also force temporary changes in water conditions. During a summer drought when hot weather evaporates water at a much faster rate, a stream's flow may taper off, causing a reduction in water movement. Fish must either adapt to the new environment or change location. Spring floods might come at a time when a species is in the midst of its spawn, resulting in the eggs being washed away or destroyed. Additionally, the entry of toxic chemicals into the water will have an immediate and disastrous effect on fish populations. Each ecosystem is fragile and the balance of nature often becomes a precarious one. Natural and human activities and events can wipe out a year class of fish or trigger undue stress on the population.

Water Purity -Type of Fish and Quality of Fish Populations

Harsh environments such as the Antarctic, deserts, jungle, and high mountains support a minimum of human life. Finding food in these extreme regions is difficult and survival is very taxing. The handful of people who live in those places often die young and are seldom the best physical specimens. More temperate and tolerant climates become home to the largest populations, where growth can be achieved with reasonable ease.

It is no different beneath the surface of the water. Healthy water environments support the strongest populations of fish and some of the largest specimens. Introduce pollution, the encroachment of human habitation, or destruction of critical habitat, and water quality suffers. This, in turn, reduces the population of fish present and frequently the size of the individual members.

When changes are introduced into a waterway, the carrying capacity may be reduced very quickly. Minor variations often make the difference. Fish are extremely sensitive animals that seldom adapt well to rapid change. They require adequate amounts of oxygen and very specific water temperatures. Water quality becomes the key to their growth and proliferation. Turbidity has to be considered a limiting factor because it disrupts the food chain and makes feeding more difficult.

In a marine environment, there are other factors that must be considered. Salinity content can be externally important, particularly in estuaries and inshore ocean waters. Excessive amount of fresh water feeding into these areas from rivers, canals, and water management areas can easily upset the balance.

Currents in an ocean can make a difference. Their edges are usually extremely rich places because nutrients from the deep surface arrive there through a process known as upwelling. Although the ocean may look uniform across the top, the water is really very different from place to place. Pelagic species of fish are constantly on the move, searching for food supplies and favourable water conditions.

Water Colour and Lure Selection

In recent years, a growing number of anglers have started using electronic gauges that measure water clarity, such as a Seechi disc. The readings from these instruments can be interpreted on a chart that suggests certain lure colours. Basically, the idea is to rely on lure colours that can be seen under the specific conditions determined by the meter. Whether or not this becomes an accepted practice remains to be seen.

Long before fishers began using these gauges, serious anglers developed their own theories about water colour and lure selection. It applies across the board whether salt or freshwater angling to all types of fishing situations. Primarily anglers use darker colours in dingy or turbid waters and prefer light shades when the water is clear. In murky water, black can be an excellent colour. It also works well, moved along the bottom. Those who use heavy jigs in salt water to probe the bottom or work the various levels in the water column rely on white as the first choice and yellow as the second.

When a fish looks at an offering that is being worked across the surface, colour becomes very deceptive. The animal really sees a silhouette, which is either dark or light. The perspective changes if a fish moves up behind the lure and views it horizontally at closer range.

Anglers recognise that colours fade with depth, but they also disappear with horizontal distance. If reds are not distinguishable in 6 metres of depth, they are also not distinguishable horizontally when they are 6 metres away.

There is a tendency to oversimplify the theories on colours underwater. How they are perceived often depends on the angle at which they are seen and the background against which they are shown. A simple gauge or chart does not account for the variety of underwater conditions.

Some of the most abundant species of baitfish are silver in colour and often nearly transparent if very small. The silver is actually a form of camouflage because it reflects the surroundings. However, predators still manage to locate and capture their prey. Fluorescent coloured lures certainly stand out, but whether or not a predator will attack something with unnatural colouration is not well known. Enough gamefish are caught on lures of every colour to convince most people that a predator might simply strike the movement rather than the colour.

Leading anglers rate lure colour a low priority when selecting a lure, believing that approach, presentation, and retrieval are far more important than the shade of the bait. These anglers are not overly sensitive and may start fishing with a dark shaded bait. If that doesn't work, they will change to something light in colour. They seldom are fussy about particular hues, but will try to make major variations from dark to light or vice versa. Recent research, however, indicates that lure colour may be more important than previously thought, and many companies are producing lures with colours identified by an electronic unit as superior for use in specific water.

Water Type and Prevalent Foods

With few exceptions, most fish are opportunity feeders. They may have a specific preference if given a choice, but they do take advantage of whatever happens to be available. When there is an abundance of a certain food, such as a major insect hatch on a particular freshwater river, the fish tend to specialise. Specialisation helps them achieve feeding efficiency, which expends less energy, than simply feeding at random.

Smaller river fish are primarily drift feeders. They maintain a lie and wait for the current to carry food to them. This may be in the form of nymphs on the bottom, crayfish, shrimps, aquatic insects at any level, or insects on the surface. These fish will also eat fingerlings and other small fish if given an opportunity. They will also take worms, grubs, crayfish, and anything else they can find.

When the body of water is not flowing, the fish must move around within a limited area and search for food. This happens in many limestone streams where plants under the surface harbour a population of insects and other small things. The same species in an impoundment or dam may also have to prowl for its food. This also applies to our common freshwater species such as the yellowbelly, silver perch, Murray cod, Australian bass and eel tailed catfish.

Yellowbelly are ambush feeders waiting for whatever happens to come by. The same fish searching for food, may school over some structure or may swim slowly scouting for a meal. The differences in behaviour and food preferences help the fish to survive under a variety of conditions. When a body of water hosts large schools of bait such as freshwater shrimps, most predators tend to follow the shrimps and feed heavily. It is always an excellent idea when fishing unknown waters to find out the primary forage species. Use or imitate the same species for bait and the results should be impressive.

Finding food in a marine environment is not any easier. Fish search for schools of bait and shadow this source of food, feeding when the urge strikes. The target could be shrimps, small mullet, pilchards, herring, or any other abundant species. When they cannot find food, most gamefish roam looking for whatever they happen upon. However, stomach samples from fish typically indicate a variety of food with a dominant item.

The most important factor lies in finding bodies of water and specific areas that support a strong food chain. When the forage is there, predators will find it sooner or later.

Other Important Considerations

Water temperature deserves even more emphasis than it has received. Assuming there is adequate oxygen, water temperature is the most important factor in determining where fish will be. When the water temperature is warmer freshwater and salt water fish become active feeders. The activity of each species is greatly reduced when the water temperature is colder and the fish seek deeper water. Temperature tolerances limit the distribution of various fish.

Even within a given body of water, slight temperature variations will affect the distribution of fish. Look for areas that are a degree or two warmer in cool weather or a little chillier in warm weather. Fish are extremely sensitive to even minor temperature variations and respond to these differences.

Along the ocean fronts, certain species such as the frogmouth and blue pilchard are present during a specific time of the year. They don't arrive until the water temperature is tolerable. When that temperature begins to change dramatically, they are gone. In many cases, no one really knows where the fish go other than that they disappear.

Sometimes, pockets of cold water along the Queensland coastline will keep a species such as mullet and tailor from migrating northward temporarily and delay their arrival at Fraser Island for instance, or to any other particular area even if that water is already within the tolerances. A great deal more is becoming known about ocean temperatures including satellite data showing where warm water and cold water gyres break off major ocean currents. Temperature is critical and certainly worthy of every angler's attention on a continuing basis.