SEA WORLD - MALVAN

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DESIGN DISSERTATION APPROVAL

for

BACHELOR OF ARCHITECTURE (B.ARCH)

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SEA WORLD - MALVAN

By

INAMDAR UZMA JAFAR

with

Exam seat no. **11ARC09**

is approved for the degree of Bachelor of Architecture.

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This thesis is the end of my long journey in obtaining my degree. There are some people who made this journey easier. Before I begin, I solemnly acknowledge **ALMIGHTY** for giving me endurance, persistence and willpower throughout. I would like to express my gratitude for all those who, knowingly or unknowingly, directly or indirectly helped me in this report. I wish to express my heart felt appreciation and sense of gratitude to all whose who lent me their continuous support and were a source of inspiration.

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INAMDAR UZMA JAFAR

DEDICATION

I learned from my mother,

"Where there is a will, there is a way."

I learned from my father,

"Always do the best job; your reputation is worth more than quick profits."

Dedicated to ones who gave me life and grew me up

Those angels who were always my supportive.

I owe them each moment of my life and praise

them in every moment.

Dedicated to the most holy person, MOTHER

(NAJMA JAFAR INAMDAR)

And the dearest person, FATHER

(JAFAR KATTAL INAMDAR)

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01 INTRODUCTION TO TOPIC

1.1 INTRODUCTION TO THE OCEAN

It is a belief that life on earth, began from the oceans. Water took centuries to covers 2/3 of earth surface and now it owes the unique position in the universe. The first form of life in the form of unicellular organisms has been found in an aquatic environment.

Oceans are thus the origin of life.

Figure 1 : ocean - with relaxing sound of waves

1.2 SOME FACTS OF OCEAN

- God, the almighty creator, build a beautiful creation- **a true masterpiece-the ocean.**
- Ocean with its infinite peaceful shades and colours of unknown chemistry; cools, calm down and smoothen the senses of man.
- It is rich in all the three kingdoms of nature-minerals, vegetable and animal.
- Marine ecosystems provide ecological riches for more than 250000 species of plants and animals.
- Fish, is that infinite order of animals, which include more than 13000 species, only 1/10th of which live in fresh water.
- Fishes and other marine creatures differing from each other in thousands of ways, continuously keep on surprising and impressing man with their beauty, elegance, power, behaviour, sizes.
- Water covers precisely 71% of the earth. Knowing the stretch of the oceans is not enough. Depth is the second dimension of the oceans. Average depth of the oceans is 3700m.
- To live at depths in the ocean, animals may be adapted to the pressure cold and the dark. Due to their dependence on light energy, Plants cannot live at depth. They are restricted to the top of about 100m of the ocean water.
- The ocean environment of the deep waters is still quite a mystery to the common man. Huge animals like mega mouth sharks have been found in the last 20 years or so.

These are some of the facts of the ocean, reminding us how little we know about the ocean.

Figure 2 : ocean with infinite peaceful shades

1.3 DEPANDANCE OF MAN ON OCEAN

The origins of life as we know it began in the depths of the oceans, and human life is still unreservedly dependent on the same oceans. Oceans are like lifeblood for planet Earth and humankind. They flow over nearly three-quarters of our planet, and hold 97% of the planet's water. The ocean is one of Earth's most valuable natural resources. Although you live very far from the shore, oceans still affect your life and the lives of your families and friends, classmates and colleagues.The air that you breathe, the food you eat, the water you drink, the products that keep you warm, safe, informed, and entertained — all can come from or be transported by the ocean.

FOOD: It provides food in the form of fish and shellfish—about 200 billion pounds are caught each year.

PROTIEN: Man requires protein in bulk and the ocean are the treasure of protein. The largest source of protein in the world is fish, and more fishes are harvested throughout the world than sheep, cattle, poultry, or eggs. Fisheries of today provide about 16% of the total world's protein with higher percentages occurring in developing nations.

TRANSPORTATION: It's used for transportation—both travel and shipping.

RECREATION: It provides a treasured source of recreation for humans. The Earth’s oceans are used for recreation such as boating, diving, surfing and sport fishing.

MINIRALS: It is mined for minerals (salt, sand, gravel, and some manganese, copper, nickel, iron, and cobalt can be found in the deep sea) and drilled for crude oil.

CLIMATE CONTROL: The Ocean plays a critical role in removing carbon from the atmosphere and providing oxygen. It regulates Earth's climate. Oceans absorb a considerable amount of the carbon dioxide created by humans when they burn fossil fuels. This helps slow human-induced global warming (climate change). Phytoplankton (microscopic floating plants) in the Earth’s oceans creates a large part of the oxygen that sustains animal life on Earth.

FRESH WATER: The oceans contain salt water, which human cannot use for drinking and watering crops. But the oceans do indirectly provide all terrestrial (land) life with fresh water, through the **water cycle**. All non-ocean life relies on freshwater runoff for their survival.

ECONOMY: Three quarters of the world's megacities are on the coast. About half of the world's population lives within the coastal zone, and ocean-based businesses contribute more than $500 billion to the world's economy. The oceans have been fished for thousands of years and are an integral part of human society. Fish have been important to the world economy for all of these years Fisheries are still enormously important to the economy and wellbeing of communities. Billions of dollars are generated annually from fishing alone and other commercial activity includes travel and recreational use of coastal waterways.

The word fishery refers to all of the fishing activities in the ocean, whether they are to obtain fish for the commercial fishing industry. The fish that are caught are not always used for food. In fact, about 40% of fish are used for other purposes such as fishmeal to feed fish grown in captivity.

PHARMACUTICLES: In addition to human dependence on the oceans for life, travel, food, work, and fun, human health is also associated with the oceans. Recent work from a multiple investigators' laboratories has shown that marine invertebrates produce compounds that have potential for development as pharmaceuticals, with applications in treatment of neurodegenerative disorders, cardiovascular and infectious diseases, and certain cancers.

Toxins found in marine plants are used as local anaesthetic. Research shows that hundreds of marine bacteria, plankton, sponges, plants. Shellfish etc. contain substances with marked antibiotic properties.

SEAWEEDS: The seas plant life is another rich resource, seaweed is an important part of the average diet and certain species are considered as delicacies. Red seaweed yields the important substance known as agar. The gel from this weed is largely used to render texture to a number of manufactured goods such as canned meat, sweets and canned foods cake icing,. Also used as a coating for pills and also in biological and medical labs in cultural media and growth of bacteria and isolated tissues.

Seaweed is widely used for alginates used as stabilizers in ice-creams jelly pie fillings foam in beer, to thicken shampoos and fabric dyes, latex rubber, paints, surface coating for paper and many more.

Figure 3 : info graphic showing benefits of the ocean

1.4 HUMAN'S IMPACT ON OCEAN

Humans depend on the ocean for many reasons including food, energy sources, transportation, and recreation. The sometimes unwise practices we adopt have created problems. Over the last two decades Deep-sea exploration has shown that the deep-sea environment has already been impacted by man.Current research shows the impacts of human activity on ocean ecosystems can be seen worldwide and in every type of ecosystem found in the oceans. Activities such as overfishing, pollution from dumping, pollution from shipping transportation, recreation use, runoff, and coastal development all have had a major impact on some parts of the world's oceans. These impacts affect most marine life, coral and rocky reefs, seamounts, estuaries, open waters, as well as shallow and deep ocean ecosystems. Most human activities including using resources from the oceans have a major impact on fragile marine ecosystems.

DAMMING DANGERS: Construction of huge hydro electrical dam can change habitats beyond recognition. Some river and stream-living species, with particular feeding habits will not be able to adapt to the change and will die off. Also the construction of a dam may mean that migrating fishes may no longer be able to swim upriver to spawn.

Figure 4 : huge hydro electrical dam

RUNOFF AND POLLUTION: Runoffis the flow of water that occurs when the soil is saturated and excess water from rain, or other sources, flows over the land and can accumulate in larger reservoirs of water including oceans. Runoff can pick up contaminants, such as toxic chemicals or pollutants, When flows along the ground. Toxic chemicals from factories and cities wash into rivers, and collect in the Earth's oceans.

Various toxins in runoff water collect by fish, either killing them directly or making them poisonous for humans. The burning of coal in factories and electric power plants releases mercury into the air. Mercury in the ocean get clean by precipitation process and gets deposited into the oceans. Mercury collects in fish and is carried up the food chain into large predator fish such as tuna. Mercury is highly poisonous to all animals, and can cause genetic and developmental defects in humans. The present high mercury level in fish now requires limits on use by children and pregnant women. Farmers often use pesticides (insect-killing chemicals), herbicides (plant-killing chemicals) and fertilizers (artificial plant nutrients), to increase crops yields. Rain washes some of those chemicals into rivers, where they are carried to the ocean. High levels of fertilizer in rivers can cause algae blooms. When the fertilizer is used up, the algae dies and begins to decay. The decomposing bacteria then use up all the oxygen in the water, causing a **fish kill**. Each year, a large area of the Gulf of Mexico becomes a **dead zone** because of fertilizer runoff in the Mississippi River from American farms.

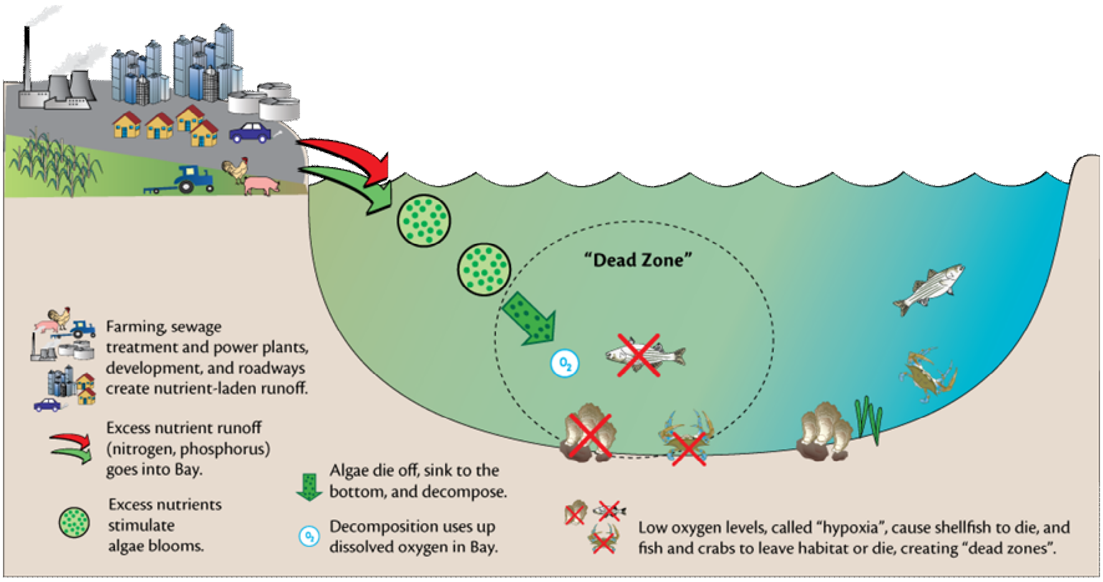

Figure 5 : process that contribute to severely low dissolved oxygen level

ARTIFICIAL REEF: Artificial reefs are man-made underwater structures built to promote marine life in areas that typically have a flat, featureless bottom. They can be intentional by placing unused or non-working structures that were once used for other purposes such as old automobiles, buses, train cars, and oil rigs down to the ocean floor. Artificial reefs can also occur unintentionally such as a ship that sinks during a shipwreck. These artificial reefs provide hard surfaces where algae and invertebrates such as coral, oysters, and barnacles can attach. As they grow and accumulate, these reefs then provide a structure for habitats and food for other marine life including many types of fish. Although they may be first used as benefits for marine life, artificial reefs may have some environmental concerns. These concerns include toxicity of some man-made structures, damage to natural ecosystems, and even

Figure 6 : artificial reef, Indonesia

Figure 7 : artificial reef, Florida

worsening the effects of **overfishing** by accumulating fish into one area.

OVERFISHING: The amount of fish available in the oceans is an ever-changing number due to the effects of both natural causes and human developments. It will be necessary to manage ocean fisheries in the coming years to make sure the number of fish caught never makes it to zero. During the last 100 years, the Earth`s human population has increased from less than 2 billion to over 7 billion. To fill human`s food needs, sea food catches have increased beyond sustainable use. Populations of many fish and shellfish species are dropping quickly because of overfishing—removing fish faster than they can reproduce.

A lack of fish greatly impacts the economy of communities dependent on the resource, as can be seen in Japan, eastern Canada, New England, Indonesia and Alaska. The anchovy fisheries off the coast of western South America have already collapsed and with numbers dropping violently from 20 million tons to 4 million tons—they may never fully recover.

In many countries, commercial fishing has found more temporarily economical ways of catching fish, including gill nets, purse seines, and drift nets. Although fish are trapped efficiently in one day using these fishing practices, the number of fish that are wasted this way has reached 27 million tons per year, not to mention the crucial habitats destroyed that are essential for the regeneration of fish stocks. In addition, marine mammals and birds are also caught in these nets. The wasted fish and marine life is referred to as by catch, an unfortunate side-effect of unsustainable fishing practices that can turn the ecosystem upside-down and leave huge amounts of dead matter in the water. Other human activities like trawling and dredging of the ocean floor have bulldozed over entire underwater habitats. The oyster habitat has been completely destroyed in many areas from the use of the oyster patent tong and sediment build up draining from farm runoff.

Most of the Earth's oceans are in international waters not governed by any one country's laws. Even when international treaties limiting overfishing have been passed, many countries or individuals have refused to obey these limits. Enforcement of these laws and treaties is difficult. As a result, the population of many of the Earth's fish species is still dropping.

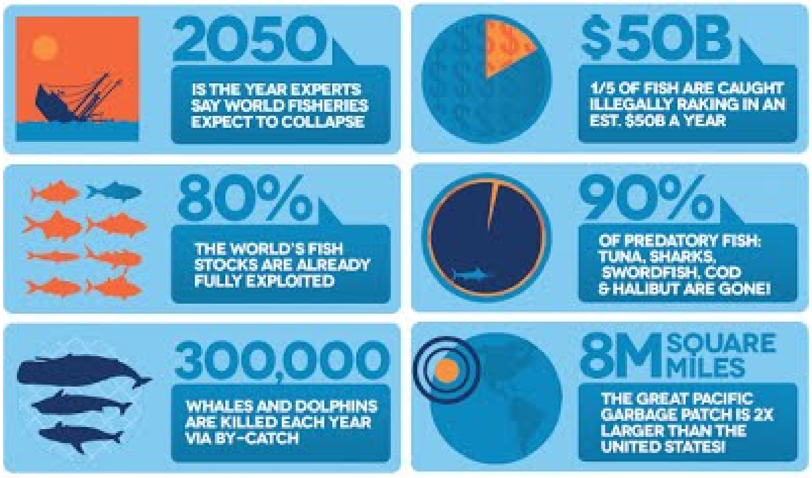

Figure 8 : socio-economic impact of overfishing

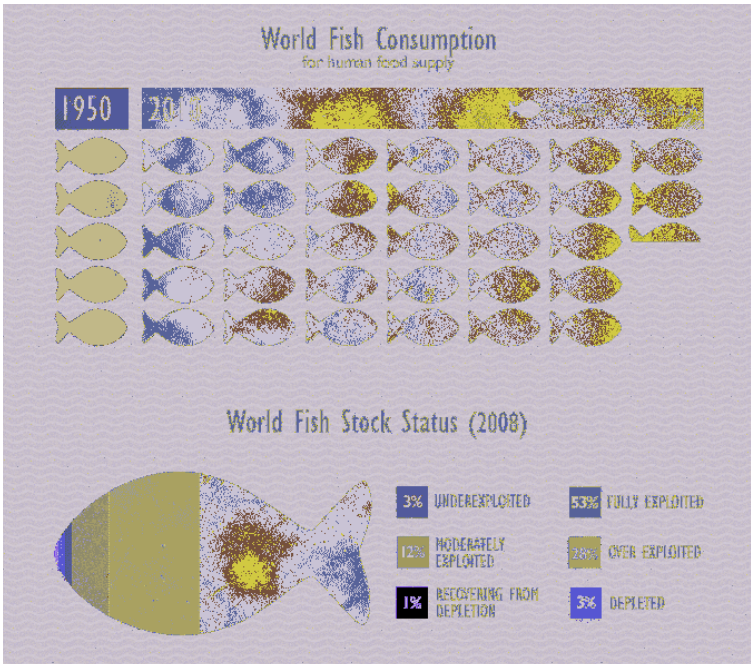

Figure 9 : world fish consumption

SHIPPING: The word "shipping" refers to the activity of moving cargo with ships in between seaports. In theory, shipping can have a low impact on the environment. It is safe and profitable for economies around the world. However, serious problems occur with the shipping of oil, dumping of waste water into the ocean, chemical accidents at sea, and the inevitable air and water pollution occurring when modern day engines are used. Ships release air pollutants in the form of sulphur dioxide, nitrogen oxides, carbon dioxide, hydrocarbons and carbon monoxide. Chemicals dumped in the ocean from ships include chemicals from the ship itself, cleaning chemicals for machine parts, and cleaning supplies for living quarters. Large amounts of chemicals are often spilled into the ocean and sewage is not always treated properly or treated at all. Alien species riding in the ballast water of ships arrive in great numbers to crash native ecosystems and garbage is dumped over the side of many vessels. Dangerous industrial waste and harmful substances like halogenated hydrocarbons, water treatment chemicals, and antifouling paints are also dumped frequently. Ships and other watercraft with engines disturb the natural environment with loud noises, large waves, frequently striking and killing animals like manatees and dolphins.

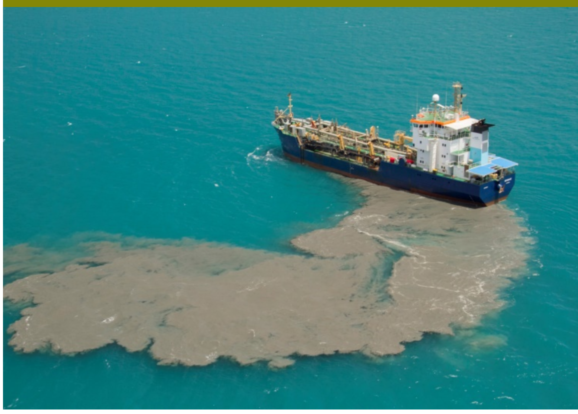

Figure 10 : oil spill in ocean

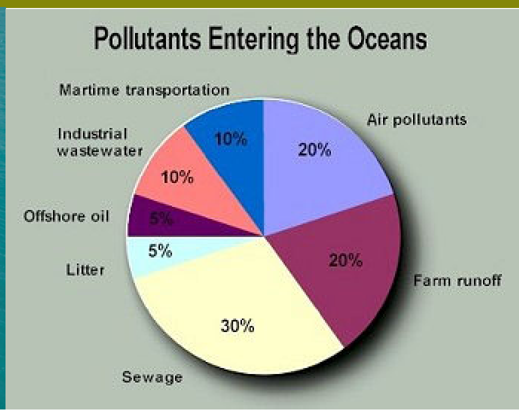

Figure 11 : pollutant in the ocean

BUSINESSES SELLING SHARK FINS: Shark populations are facing steep declines due to many years of exploitation with a large part of that for their fins for soup (too often by the cruel practice of shark finning. Their slow reproductive rates make them extremely vulnerable to extinction and their disappearance is causing dangerous imbalances in marine ecosystems the world over.

Figure 12 : over fishing of sharks for their fins

MINING: Humans began to mine the ocean floor for diamonds, gold, silver, metal ores like manganese nodules and gravel mines in the 1950's when the company Tidal Diamonds was established by Sam Collins. When diamonds are mined, the ocean floor is dredged to bring it up to the boat and sift through the sediment for valuable gems. The process is difficult as sediment is not easy to bring up to the surface. Metal compounds, gravels, sands and gas hydrates are also mined in the ocean. Mining of manganese nodules containing nickel, copper and cobalt began in the 1960's. Mining the ocean can be devastating to the natural ecosystems. Dredging of any kind pulls up the ocean floor resulting in widespread destruction of marine animal habitats, as well as wiping out vast numbers of fishes and invertebrates. When the ocean floor is mined, a cloud of sediment rises up in the water, interfering with photosynthetic processes of phytoplankton and other marine life, in addition to introducing previously benign heavy metals into the food chain. As minerals found on land are exploited and used up, mining of the ocean floor will increase.

MINING OF REEFS: In several parts of the Pacific Ocean, mostly off Sri Lanka and around the island of Bali, huge areas of corals have been removed by mining to provide stone for roads and buildings and lime for making cement.

Thousands of tons of the most attractive varieties of coral reef are sold as souvenirs, or carved into ornaments or jewellery. Bit by bit the reefs are disappearing in front of the respected authorities. In some areas the black coral is almost extinct. Animals that live on the reefs create many of the most valuable sea shells, perfect specimen are found by diving for live animals. Out of 100, 99 are thrown off because their shells are not perfect enough.

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If this continues some species of coral, shellfish and fish are bound to disappear. This will create a series of small holes in the food chain and other relationships, which bind the coral ecosystem together. The removal of a reef not only destroys an ecosystem; it also leaves the coastline exposed to the full fury of the sea.

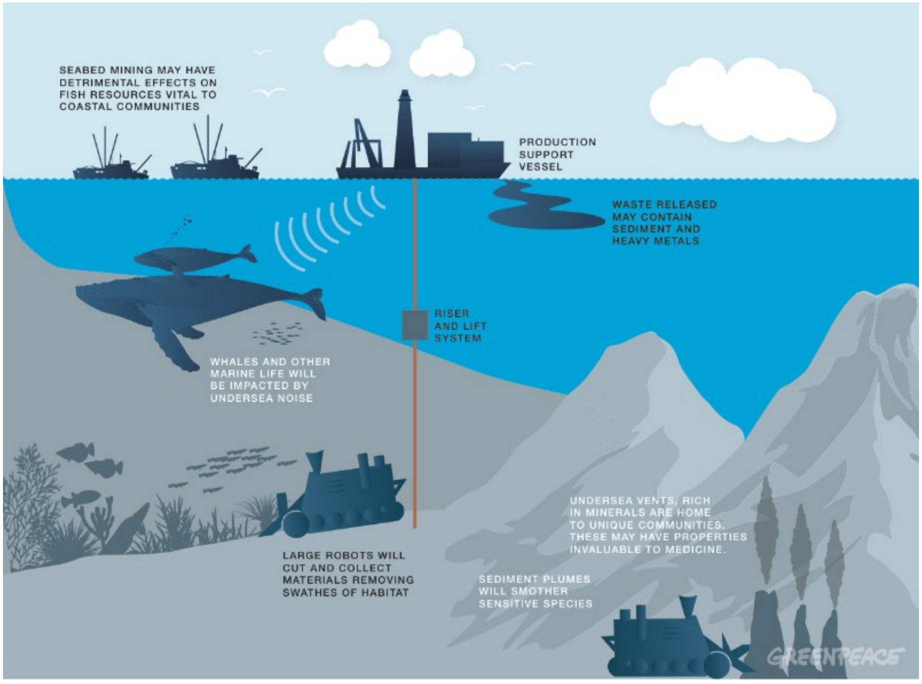

Figure 13 : deep sea mining

DEFORESTATION AND HABITAT DESTRUCTION: Wetlands, estuaries and protected bays along ocean coasts are important breeding grounds for fish and shellfish. Many of these essential habitats have been destroyed by human development and pollution. This habitat destruction will make it even harder for fish populations to recover. Rainforest is the home of many aquatic fishes. Deforestation is the main influence on the aquatic environment of the tropics. Big portions of these forests have been cut down for short term farming projects by the governments. The land is used for a couple of six years until it gets exhausted, then it is left idle and useless and the farming moves to the next area. Burning of these rain forest trees increases the carbon dioxide levels in the atmosphere and causes global warming and appearance of abnormal weather conditions throughout the world. Disappearance of the forest produced a new flood plain. When water flows through such a land it takes along with it all the nutrients on the surface. As timber collecting and mining has increased in order to meet the demands of the developing World, they too have caused massive destruction. Another effect of these industries is that the soil may be washed down the rivers where it can smother fish habitats, even affecting fishes living in the coral reefs right out in the sea.

Figure 14 : rainforest destruction

Figure 15 : converting rainforest into Cattle farm

OCEAN CURRENTS AND FLOATING GARBAGE: Most of the Earth's oceans have circular currents that create a whirlpool-like point at their centre where floating garbage collects. Both the Pacific and Atlantic Oceans have vast areas filled with floating garbage, including foam and plastics that will take many centuries to break down. This garbage is sometimes eaten by fish, turtles and seabirds, causing their premature death.Floating garbage may wash up on beaches, requiring expensive clean-up and disposal.Because most of these floating garbage dumps are in international waters, no one country is responsible for cleaning it up. It is likely that these floating garbage dumps will continue to fill in the future.

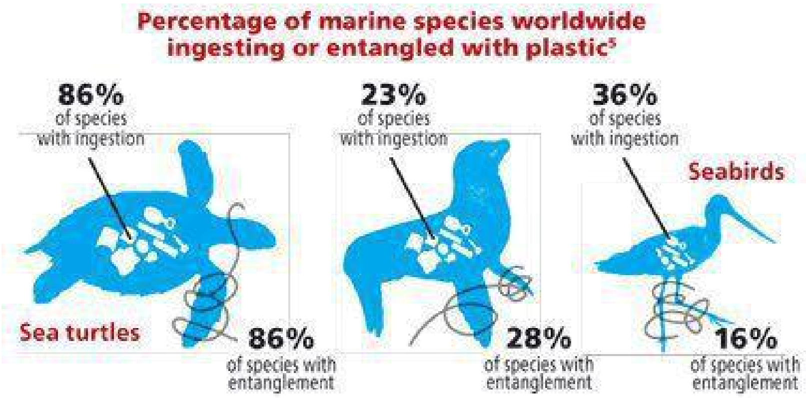

Figure 16 : endangered species due to garbage in the ocean

CLIMATE CHANGE AND RISING SEA LEVELS: Scientists believe that the Earth's climate is warming, due in part to human burning of fossil fuels and the resulting collection of carbon dioxide in the air. Carbon dioxide is a greenhouse gas that helps trap heat in the Earth's atmosphere. The warming planet is causing an increase in glacial melting, adding additional water to the Earth's Oceans. Floating ice is also melting, causing the darker open Arctic Ocean to absorb more heat from sunlight. The warming water is also expanding, since warm water is less dense and takes up more volume than cold water. Scientists predict that the Earth's sea levels will continue to rise over the coming centuries. Future sea level rise could create a massive displacement of human populations from coastal cities and low-lying areas, and result in the complete destruction of island countries. Rising sea levels could also destroy wetlands that serve as the nurseries for fish populations. Warmer oceans may fuel stronger or more frequent hurricanes causing additional damage to coastal cities. As more carbon dioxide becomes dissolved in ocean water, the acidity of the water increases, making it harder for shell-creating organisms to survive. The producer base of the ocean food chain depends on shell-creating organisms. The entire ocean food web could be seriously damaged or even collapse if oceans become too acidic. Coral reefs depend on a narrow range of temperatures to survive. As ocean temperatures rise, coral reefs may die, further reducing the fish populations that coral reefs support.

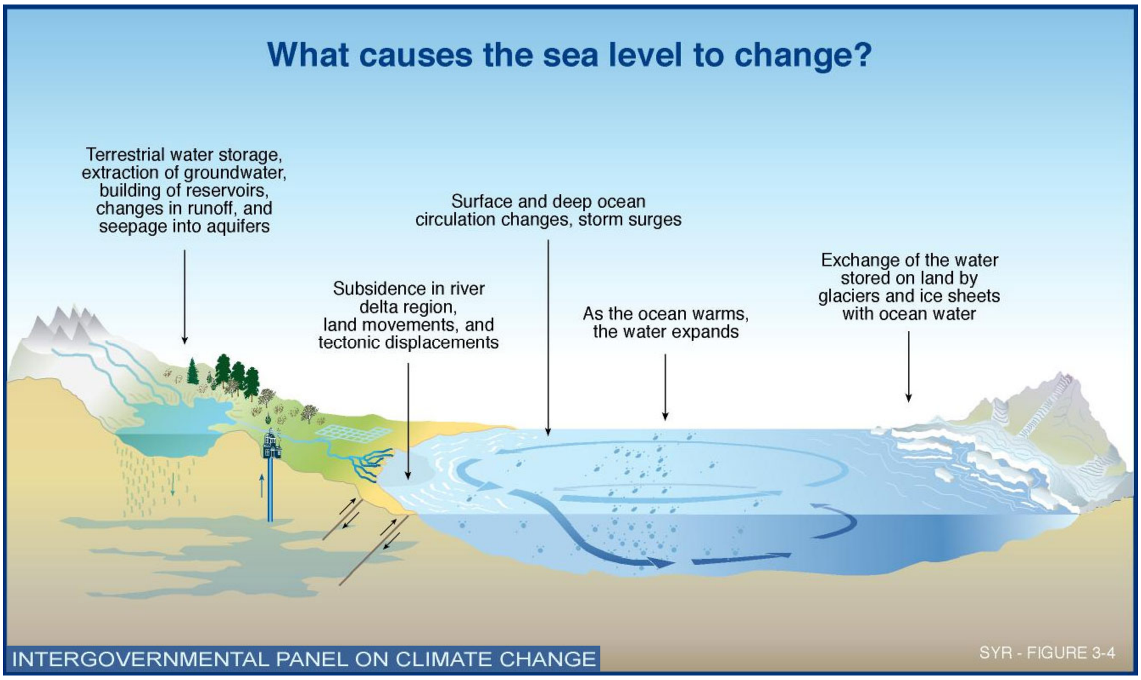

Figure 17 : climate change and rising sea level

LIVE CAPTURES: Most cetacean capture methods are extremely traumatizing such as drive captures. This hunt involves a fleet of small boats that herd dolphin pods into shallow water by producing loud noises when the crews bang on hulls, or clang metal pipestogether underwater. Some of the animals are set aside for sale to captive display facilities, while the remainder are killedwith long knives or spear-like tools Aside from humane considerations, removal of animals from wild populations can have a substantial negative impact on the animals left behind.

Figure 18 : live drive captures of dolphins for meat and trade for captive industry

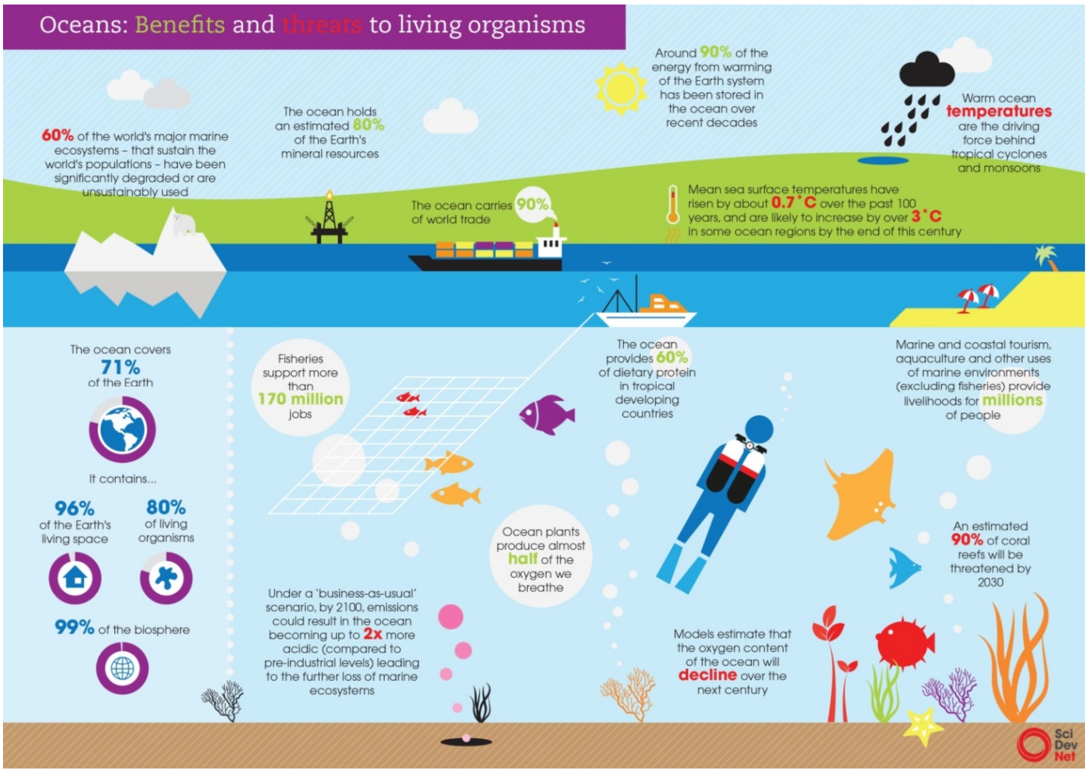

Figure 19 : ocean benefits and threats to living organism

02 SYNOPSIS

INTRODUCTION

Mankind have always been curious in exploring the world around them. They always try to gain the deeper knowledge about the natural resources, their importance, their uses, and the built unbuilt environment around them. Among all the natural resources, ocean is the most fascinating one. Man had always struggled to know the secrets about under water life. But in this battle, the layman's knowledge usually remains to theoretical database, seashore and fishes.

An ocenarium is a place where one can reveal the secrets of underwater. Ocenarium provides exciting insight to the ocean to those with acquiring minds, as well as nature lover, tourist, children and experts. It not just involves people by entertaining them but also brings awareness among common people to conserve marine life.

AIM OF THE PROJECT

To design an ocenarium for all category of people of all age groups and gender by maintaining the natural environment of the aquatic plants and animals. To attract foreign tourists mainly and also promote weekend family tourism from the metropolitan cities. To spread awareness and studies related to oceanography. To conserve and propagate marine life.

OBJECTIVES

- Maintain ecological balance by restoring marine life and propagate them in their natural environment.
- Educate people and about marine life which is beyond their reach.
- Reap benefits through foreign exchange.
- To give understanding to the people by making them aware of urgency and importance of conservation of marine life through entertainment.
- To make people realize their responsibility towards other natural resources like marine life.

SCOPE OF WORK

India has a vast coastal line approx. 1/3 of it. 30% of people in India live on sea shore and completely depends upon sea. Since India has a deep relationship with water and marine life since beginning, it becomes necessary to create awareness among people to conserve and propagate marine life. As India has a very few aquatic centres there is a need to reboots the same. This project will act as a research, tourist, recreational and education centre.

03 CONSERVATION OF OCEAN AND MARINE LIFE

Any activity that man spoils against the balance of the ecological symbiotic cycle will harm none but him. In a country like India with a long coastline and 30% of the people living on the shore man's dependence on the sea and the life it nurtures cannot be ignored. Now it's his turn to contribute to the symbiotic relationship.

Here in these circumstances, efforts to conserve the marine ecosystem propose to bridge the gap. With dishonourable activities of over fishing and dumping chemical wastes into the sea, concerns to conserve marine life to materialize in the form of extensive conservation schemes.

Different ways to conserve ocean and marine life are as follows:

1. Oceanarium
2. Aquariums
3. Dolphinarium
4. Marine Mammal Park
5. Marine Park
6. Rescue and rehabilitation centre
7. Research centre
8. Breeding centre
9. Aqua-farming

4.1 OCEANARIUM

An oceanarium means underwater aquarium. In oceanarium one can see the marine creatures in their natural habitat. It is basically a salt-water aquarium for displaying marine animals & plants particularly oceanic, pelagic, fishes and mammals. The modern concept of the term oceanarium is a huge and gigantic aquarium- an artificial ocean habitat with all kinds of marine creatures, especially large ocean dwellers such as sharks and dolphins. It is an advance form of an aquarium, often located on the ocean or on a bay or river and features outdoor pools and aquatic environments that enable visitors to see large and small fish and other marine life from below the water surface. The underwater aquarium concept is a revolutionary concept in entertainment along with education which bases its drawing power on our natural human curiosity of other forms of animal life.

4.2 AQUARIUMS

An aquarium is a specially designed device that acts as an artificial habitat for water-dwelling animals. Although most people associate an aquarium with tropical fish, aquaria can also be used to house amphibians or large marine mammals. In addition, many aquaria contain a variety of plant species.

They are made from reinforced concrete and plastics to create a tank that is large enough to hold an entire underwater ecosystem. Most public aquaria can be considered biotopes, ecotypes, or ecotopes since they house plants, fish, and invertebrates that would only live together in a natural habitat. Sharks and whales are some of the most common species found in public aquaria, although otters, penguins, and other semi-aquatic animals are often quite popular.

4.3 DOLPHINARIUM

A **dolphinarium** is an aquarium for dolphins. Either for research or for public performances, the dolphins are usually kept in a large pool, though occasionally they may be kept in pens in the open sea, Some dolphinariums consist of one pool where dolphins perform for the public; others are part of larger parks, such as **marine mammal parks**, zoos or theme parks, with other animals and attractions as well.

4.4 MARINE MAMMAL PARK

A **marine mammal** is a commercialtheme park or aquarium where marine mammals such as dolphins, beluga whales and sea lions are kept within water tanks and displayed to the public in special shows. A marine mammal park is more involve many carefully arranged parts or details; detailed and complicated in design and planning than a **dolphinarium**, because it also features other marine mammals and offers additional entertainment attractions. It is thus seen as a combination of a public aquarium and an amusement park. Marine mammal parks are different from marine parks, which include natural reserves and marine wildlife sanctuaries such as coral reefs, particularly in Australia.

4.5 MARINE PARK

A **marine park** is a park consisting of an area of sea (or lake) sometimes protected for recreational use, but more often set aside to preserve a specific habitat and ensure the ecosystem is sustained for the organisms that exist there. Most marine parks are constructed by governments, and organized like 'watery' national parks.

4.6 RESCUE AND REHABILITATION CENTRE

In **rescue and rehabilitation centre** they rescue marine mammals for many different reasons, including malnourishment, separation, entanglements, and diseases, but nearly 10% of the animals we rescue have been impacted by human interaction and hazards like net and fishing line entanglements, gun shots, illegal pick-ups, and boat. After an animal is rescued, we bring it to our hospital. After a successful rehabilitation, the ultimate goal is to release the animal back to the ocean. They rescue and humanely treat ill, injured, or orphaned marine mammals, and return healthy ones to the wild.

4.7 MARINE RESEARCH CENTRE

The **marine research centre** is an organization dedicated to furthering the knowledge of the oceans of our world and the organisms that inhabit them. It is in these labs that the knowledge of the ocean is analysed and the new findings are discovered. The main goal of this centre is to further the knowledge of the oceans by providing the research facilities and the equipment that are lacking in that particular area of research.

4.8 BREEDING CENTRE

It is a centre where endangered or popular fishes are kept for breeding. Male and female fishes kept in a very suitable artificially manmade environment under controlled condition so that they can breed fast and endangered species can conserve.

4.9 AQUA – FARMING

Aquaculture, also known as **aqua farming**, is the farming of fish, aquatic plants,algae, crustaceans, molluscs and other aquatic organisms. Aquaculture involves cultivating freshwater and saltwater populations under controlled conditions, and can be contrasted with commercial fishing, which is the harvesting of wild fish.Mari culture refers to aquaculture practiced in marine environments and in underwater habitats. Particular kinds of aquaculture include fish farming, shrimp farming, oyster farming, mariculture, algaculture (such as seaweed farming), and the cultivation of ornamental fish. Actual methods comprise aquaponics and integrated multi-trophic aquaculture, both of which integrate fish farming and plant farming.

04 OCEANARIUM – A SIGHT

8.1 INTRODUCTION TO OCEANARIUM

An oceanarium can either be a marine a marine mammal park or a large scale aquarium presenting an ocean habitat with marine mammals. It is a commercial theme park or aquarium where marine mammals such as dolphins, beluga whales and sea lions are kept within water tanks and displayed to the public in special shows.

An oceanarium means underwater aquarium. One can see the marine creatures in their natural habitat in oceanarium. Many recreational activities can combine with the oceanarium to make it a complete recreational space for any age group. It is basically a salt-water aquarium for displaying marine animals & plants. It serves as a center for public entertainment and education and scientific study. They are basically located in coastal areas.

The modern concept of the term oceanarium is a gigantic and massive aquarium- an artificial ocean habitat with all kinds of marine creatures, especially large ocean dwellers such as sharks and dolphins. It is an advance form of an aquarium, often located on the ocean or on a bay or river and features outdoor pools and aquatic environments that enable visitors to see large and small fish and other marine life from below the water surface. The underwater aquarium concept is an innovative concept in entertainment along with education which bases its drawing power on our natural human curiosity of other forms of animal life.

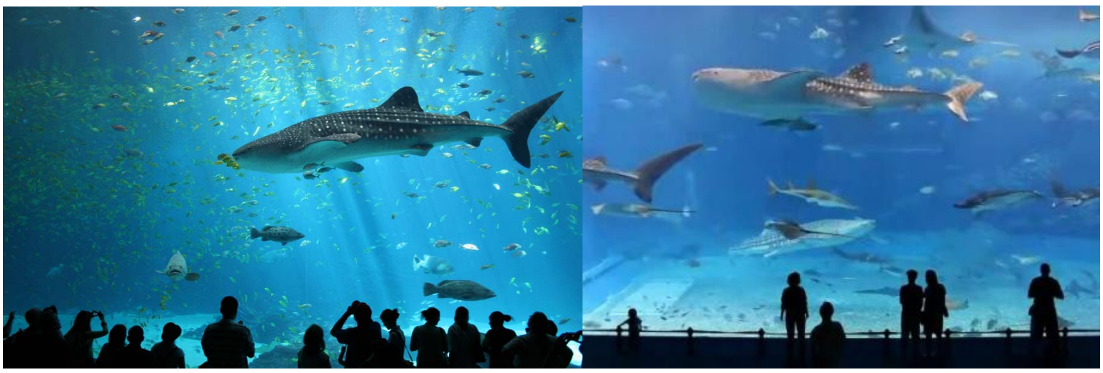

Figure 20: Male Whale Shark at Georgia Aquarium

8.2 HISTORY OF AN OCEANARIUM

Man’s curiosity towards other wild creatures has led to the capturing and holding of these creatures by man. Man’s reasons and methods of doing this were different in each situation. Man’s need to these wild creatures has developed Into, in many instances, the establishment of a modern day institution. For example, the birth of the modem day aquarium can be traced back to manes earliest beginnings and his Attempts to house fish in some sort of artificial environment.

The earliest civilization known to used artificial environments to house fish were the Sumerians. Almost 4,500 years ago the Sumerians used artificial ponds to keep fish. These fish were kept either for food or possibly entertainment. In addition to the Sumerians, other ancient civilizations such as Egyptians and Assyrians were known to have kept fish as well. It is most likely as a food supply. The ancient civilization of China is also known to have had positive results in keeping fish. The Chinese were known to have raised fish for food as early as 1000 B.C. In addition to raising fish for food, the Chinese were also the first to have some degree of success in breeding of fish, such as the ornamental goldfish and crab. The ancient Romans were the first people to put a major effort into the containment of fish. The Romans spent large amounts of time, effort and money in the construction of tanks for holding fish. The tanks they constructed were directly connected to the ocean through a network of channels used to keep a continuous flow of fresh sea-water running through the tanks. The Romans ran these not only to the tanks they used to raise fish for food in, but also to aquariums they had in their banquet halls.

Approximately 2.500 years later, in China, where breeders had to continue to experiment with developing multi-colored fish, the first book on aqua' Mill management was written, in 1596, by Chan Chaien-te.

Even though many of the earliest civilizations had been developing methods for artificially housing for thousands of years, it was notuntil the 18th century that this idea was brought to the a ‘civilized’ western world. It was not until 1711 when goldfish were brought to London that the idea of keeping fish in an artificial enclosure (the glass fish bowl) was introduced to Europe. It took another one hundred years, around the middle of the 19' century, before aquariums began to establish themselves in Europe.

The purpose of these original aquariums was a devotion to scientific research. These aquariums devoted to research began to appear around 1850 and centered on studying the natural aquatic environment. A real interest was sparked in aquatic life by Phillip Gosse, who was the first to use the term aquarium, to describe the artificial containment of fish. From this beginning the first aquariums, as we think of them today, began to appear. The very first public aquarium opened in London, England in 1853. This aquarium was a part of the Zoological Gardens, which contained a collection of standing water tanks, housed in a small building called the Fish House.

Within the next several years aquariums were established in many of the world's major cities. In 1856 the first public display aquarium was opened in New York City by P. T. Barnum. These first aquariums, because of complications inherent in the keeping of fish, were forced to close soon after they appeared. However, by the beginning of the 18700's many of the problems that had forced the closing of the first aquariums had been solved and aquariums once again began to open. The intention of these first aquariums, built between 1850 and 1880, was to create the illusion that the visitor was entering into the world under the sea.

Around the turn of the century the public aquarium had become a worldwide institution. The function of aquariums of this time period was similar to the function of a museum. This type of aquarium, however, did not last long. Soon after the turn of the century a new kind of aquarium developed. **This new type of aquarium was called oceanarium.** The first one to open was in St. Augustine, Florida in 1938. An oceanarium is made up of large open air tanks that are supplied directly from the ocean With fresh sea water. Soon afterthe appearance of the oceanariurn, practically all growth of all types of aquariums slowed dramatically because of the breakout of World War II.

Since World War ll many of the world's major cities have added aquariums into their public facilities. The purpose and intent of these modern facilities, in contrast to the earlier aquariums. is to try and illustrate the natural environment as realistically as possible for the specimens being exhibited. This effort of trying to exhibit specimens in their natural environment has lead to an evolution of the modern aquarium. This evolution of the modern aquarium has produced two additional variations of the modern aquarium. The first of these two aquariums is devoted entirely to research. The other is the commercial aquarium.

With the development of these more sophisticated and technical many problems and techniques used in early aquariums have had to be improved on. For example, the filtration systems have gone enormous changes from those used in the first aquariums. Specifically, the public aquarium has had to struggle with the problem of pedestrian circulation. With the increasing popularity of aquariums in recent years, the modern aquarium is surely to continue to be of mans most loved institution.

EVOLUTION:

1ST GENERATION AQUARIUM - The Small size tank with 1 side of the tank is transparentAlso the size of the fishes are small

↓

2ND GENERATION AQUARIUM - The size of the tank is larger but not larger enough to house mammals

↓

3RD GENERATION AQUARIUM - CALLED OCEANARIUM - The tanks are much larger around 9m in depth with larger acrylic panel.

↓

NEXT GENERATION OCENARIUM - These tanks mainly consists of 180 degrees which allow visitors to partly experience the habitat of these animals

↓

PRESENT OCEANARIUM - Most modern Form of an aquarium with 360 degrees tunnel. Which allow the visitors to experience how it feels to be in an enviroment similar to these animals.

8.3 CLASSIFICATION OF DISPLAY

The Variation Between marine species Depends Upon The Kind OF Ecosystem It Follows:

1. **Based on salinity of water**
2. **Based on temperature**
3. **Based on species type**

05 ALL ABOUT FISHES

13.1 HISTORY OF FISHES

Fishes have truly an ancient lineage, one stretching to more than 400 million years. By way of comparison, whales, the masters of the great oceans as they seem to us, have existed for just 55 million years. Yet though there is this long history of fishes we know surprisingly very little about them. Their domain the aquatic regions of the world comprising the whole 70% of the earth surface, became available to serious scientific study only about 50 years ago. The breakthrough came with the invention of the scuba diving instruments. This gave the ichthyologists an opportunity to observe relatively unhindered, the natural behaviour of the many species of fishes. From the available archaeological evidence, we are aware that fishes have been important as a food source since prehistoric times to the coastal tribes and the people living near the seacoast.

Figure 21 : Huma Trigger **Figure 22 : Blue Halfmoon Beta Fish**

Shallow swimming fishes were taken with rudimentary spears and clubs deeper swimming was taken with nets. But it was not until ancient Egyptian times that we know of fishes kept and bred not only as ready supply of food but, more importantly from an aquarist's point of view, because of their ornamental use.

As a food source the Egyptians preferred rearing the Tilapia species, while for their beauty they kept mormyrids, which were regarded as sacred animals. There is tenuous evidence that the gold fish, selectively bred carp, date back to the Tang Dynasty of China, (AD 618-AD907), but stronger evidence also exists for their presence in China during the sung dynasty (AD 970- AD1278).

The introduction of the gold fish in Europe was delayed, however and they did not reach England till the end of the 17th century. But within the next hundred years they became widespread in ornamental ponds and lakes. Back in Europe in the mid-19th century fish keeping was becoming a serious affair. In 1853 in the London Zoological Society established a public aquarium with the assistance of Philip Gosse, who spent some time developing his concept of the balanced aquarium, one which there was aquatic plants and animals. Gosses' concept of a balanced aquarium has become crucial in the development of fish keeping, as we presently know it. Many aquariums were attempted tanks that housed fishes caught locally in the rivers and found in the rock pools. There were thus tanks loosely related to a single habitat. With the advent of air travel, exotic fishes from all over the world became available and with them came the concept of community aquarium In these, the mixed populations from widely different habitats were introduced together; the only thing these fishes had in common, apart from tolerating the same general conditions of the water, was an easy going and indulgent nature.

Figure 23 : Gold Fish

Figure 24 : Yellow Tang Fish

13.2 CLASSIFICATION OF FISHES

1. **Fresh water fish**
2. **Marine water fish**
3. **Ocean mammals**

1. FRESH WATER FISH

Fishes can be divided into certain groups, each one made tip of various genera that are useful categories for the aquarists. On looking at most of the fresh water fishes, there are simple external characteristics that allow you to make a tentative identification of the fishes group. These include body shape, coloration, fins, mouth and teeth, plus other specialized traits. Based on these features, the majority of the fresh water fishes can be divided into seven major types:

1.1 Catfish:

These fishes have been found to have around eight barbells round the mouth; sometimes these are long and whiskery. Often a ray less adipose fin sits behind the dorsal fin. The dorsal fin may have very strong fin rays, which are sometimes serrated. The pigmentation might be quite dull and some species have no scales.

Figure 25 : Cat Fish

1.2 Loaches:

Similar in some ways to a catfish, leaches have no adipose fin. They are generally small fishes. they may have long snake like bodies. They have six small barbells around the mouth. The dorsal fin is often close to the middle part of the body, which may be brightly colored.

1.3 C

haracins:

These have true fish shaped body, scaled and often with a metallic coloration: some are fluorescent. The fins may be colored and there is a small adipose fin. The males in this group also have a tiny hook on their anal fin. The males of some of the species also have a tiny hook in their anal fin. The mouth is always terminal and contains teeth the majority of the fish in this group originate in South America.

Figure 7 : Characins

1.4 Bar

bs and rasboras:

Members of this group are classically fish shaped and are obviously scaled and often brightly colored. The dorsal fin is often setback on the body and there is often no adipose skin. Must have barbells, although these are inconspicuous. The mouth, which is terminal, has no teeth.

Figure 8 : Barbs Fish

1.5 Liv

e bearing and egg laying tooth carps:

Usually less than 2 inches long, these have a flat-topped head with small, upward facing mouth. The dorsal fin is usually set back on the body.

Figure 9 : Guppy Live Bearer

1.6 Cic

hlids:

Often brightly colored and with bands and bars as markings. these fishes have a terminal mouth. Many of them also have a large dorsal fin and deep body.

Figure 10 : Chichilds

1.7 Labyrinth fishes:

Externally similar to the cichlids: the anal fin of Asiatic species trails to the level of the dorsal fin or beyond it. In the African species this feature is not as prominent instead look for a serrated edge to the top of the gill cover. These labyrinth species often have marbled body markings.

1.8 B

ichirs and Reed fishes:

Bichirs and reecifish The bichirs are a family, rolypteridae, of archaic-looking ray-finned fishes, the sole family in the order rolypteriformes. All species occur in freshwater habitats in tropical Africa and the Nile River system, mainly swampy, shallow floodplains and estuaries.

1.9 C

yprinids:

Cyprinids commonly called the carp family or the minnow family. Its members are also known as cyprinids. It is the largest family of fresh-water fish, with over 2,400 species in about 220 genera.

Figure 29 : Cyprinids

1.10

Kill fish:

Killifish The name killifish is derived from the Dutch word "kikie". meaning small creek, puddle. Because of living in ephemeral waters, the eggs of most killifish can survive periods of partial dehydration. Like seeds, the eggs can be sent by mail without water.

1.11

Puffer fish:

Pufferfish The family includes many familiar species which are variously Gilled pufferfish, blowfish, bubblefish, globefish. Swell ash, toadish, toadies, honey toads, and sea squab.

1.12

Neotropical Electric fish:

Neotropical electric fish The Gymnotiformes are a group of teleost bony fishes commonly known as the Neotropica or South American knifefishes. They have long bodies and swim using undulations of their elongated anal fin.

Figure 32 : Electric Fish

1.13

Rainbow Fish:

Rainbowfish The rainbowfish are a family of small, colourful, freshwater fish that are found in northern and eastern Australia and New Guinea and in the Southeast Asian Islands.

Figure 33 : Rainbow Fish

1.14

Spiny eel Fish:

Spiny eels The Mastacembelidae are a family of fishes, known as the spiny eels. Spiny eels generally inhabit soft-bottomed habitats in fresh and brackish water. These fish have an eel-like body. Some of these fish can reach a maximum length of about one metre (40 in).

2. MARINE WATER FISH

Since there are many more marine species it is not easy to classify them using the same kind of distinctions as are for the fresh water fishes, but basic visual descriptions can be given for ten groups that are most commonly seen in the aquaria.

2.1. Surgeon and tangs:

These are deep-bodied fishes with compressed sides and a high profile. They have sharp spines protruding from the neck of the tail. These spines can be erected or can be left flat.

2.2. Angelfish and butterfly fish:

This group is similar to the surgeons and the tangs but there are no spines on the caudal peduncle, although angelfish have a spine protruding from their lower gill cover. The color and patterns of these species is specially designed for camouflage or species recognition.

Figure 37 : Pink Angel Fish

Figure 35 : Cardinal Fish

2.3. Cardinal fish:

There are two obvious erect dorsal fins and large mouth. Being nocturnal they have large eyes.

2.4. Squirrelfish:

They form another group with large eyes, as they are nocturnal. The dorsal fin has a strongly rayed front section and a high standing back section with softer eyes.

Figure 38 : Big Eye Squirrel Fish

2.5. Triggerfish:

These reef dwellers have a double dorsal fin. Although the front one is carried folded, it can be erected and locked in place. Their long faces and terminal mouths are designed for picking invertebrates off the reef.

Figure 39 : Trigger Fish

2.6. Wrasse and Rainbow Fish:

Most members of this group have the classic fish body shape, but some are deep bodied. There is a single, extended dorsal fin and terminal or slightly downward racing mouth.

Figure 40 : Wrasse Fish

2.7. Blennies:

Although long in the body, these have a flattened, building typeface. The eyes are set high, often with whiskery "eyelashes".

Figure 41 : Black Blenny

2.8. Gobies:

Distinguished by their fairly elongated brightly colored bodies, gobies have pelvic fins modified for grasping rocks, although they may resemble blennies have no "eyelashes".

Figure 42 : Mandarin Dragonet
Figure 43 : Yellow Goby

2.9. Mandarin Fish:

Similar to the blennis but they have sorter bodies, double dorwal fin with a leading edge extended. They include some extremely brightly coloured species.

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3. OCEAN MAMMALS

3.1. THE KILLER WHALE

Environment, Physical Characteristics and Food

Killer whales inhabit coastal waters in most parts of the world. Throughout time " the killer whale - boldly marked in black and white, has often been seen in waters frequented by man, and is now recruited as the star performer in oceanarium - and is one of the most familiar marine mammals."' Although named the killer whale by early fishermen, the mammals scientific name is *Orcinus orca,* it is the largest member of the dolphin family. *Orcas* are carnivores and have a reputation for being voracious eaters.

The diet of most of the members of the dolphin family is made up mainly of small fish. Although dolphins do have teeth they are primarily used to grab their food and are not used for tearing or chewing. Most members of the dolphin family prefer to gulp down their prey whole. Killer whales, like other members of the dolphin family, have teeth. However, unlike their smaller counterparts, the killer whales use their teeth to tear off chunks of their prey. "In each half of their jaw the killer whales have ten to fourteen sharp teeth; these may be worn down in older members of the species. When their prey is not too large, they will gulp it down whole.

Figure 44 : The Killer Whale

Like other members of the dolphin family "[t]he killer whale *{Orcinus orca)* cruises throughout North Pacific waters in all months of the year. It ranges, in fact,through all seas of the world to the very limits of polar fast ice."However, unlike smaller dolphins, the killer whale has several characteristics which are not commonly found in other members of the species. The use of their teeth for feeding is oneAnother characteristic which is unique to the killer whale is its ability to make long dives, from one to ten minutes in duration, while maintaining relatively high speeds.

Although the extreme weight of these mammals seems excessive in comparison to large land inhabiting mammals, a good deal of the weight is offset by their underwater habitation. The extraordinary size of these creatures is not limited solely to their weight. "The killer whale's flipper or "hand" is broad and rounded, like a large table — tennis paddle. In the male, it may reach a length of 6.7 feet and a width of 4 feet, while the width of the tail flukes, tip to tip, may reach 9 feet." The dorsal fin, a large triangular appendage, is located on the center back of the animal. In "...the male it attains a height of 5.6 feet, and that of the female about 3 feet."

Figure 45 : The killer Whale diving

3.2. BELUGA WHALE

The **beluga whale** or **white whale** (*Delphinapterus leucas*) is an Arctic and sub-Arctic cetacean. It is adapted to life in the Arctic, so has anatomical and physiological characteristics that differentiate it from other cetaceans. Amongst these are its all-white colour and the absence of a dorsal fin. It possesses a distinctive protuberance at the front of its head which houses an echolocation organ called the melon, which in this species is large and deformable. The beluga's body size is between that of a dolphin's and a true whale's. The species presents a moderate degree of sexual dimorphism, as the males are 25% longer than the females and are sturdier. Adult male belugas can range from 3.5 to 5.5 m (11 to 18 ft), while the females measure 3 to 4.1 m (9.8 to 13.5 ft). Males weigh between 1,100 and 1,600 kg (2,400 and 3,500 lb), occasionally up to 1,900 kg (4,200 lb) while females weigh between 700 and 1,200 kg (1,500 and 2,600 lb). They rank as mid-sized species among toothed whales. A large percentage of its weight is blubber, as is true of many cetaceans. Its sense of hearing is highly developed and its echolocation allows it to move about and find blowholes under sheet ice.

Belugas are gregarious and form groups of up to 10 animals on average, although during the summer, they can gather in the hundreds or even thousands in estuaries and shallow coastal areas. They are slow swimmers, but can dive to 700 m (2,300 ft) below the surface. They are opportunistic feeders and their diets vary according to their locations and the season. The majority of belugas live in the Arctic Ocean and the seas and coasts around North America, Russia and Greenland; their worldwide population is thought to number around 150,000. They are migratory and the majority of groups spend the winter around the Arctic ice cap.

Conservation Status:

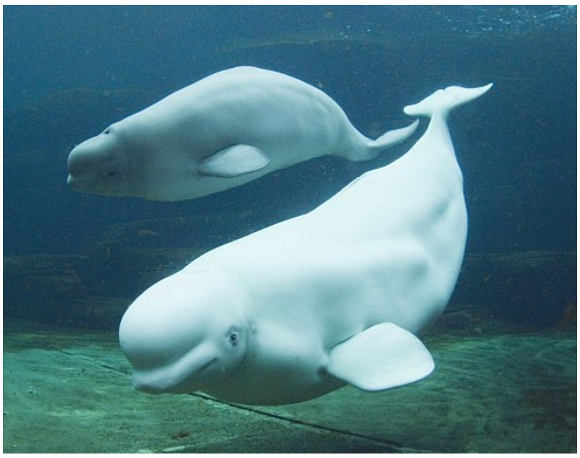
They are considered a near threatened species.

Figure 47 : Conservation Status of Beluga Whale

Figure 46 : The Beluga Whale

3.3. BOTTLENOSE DOLPHINS

- CLASS: Mammalia
- ORDER: Cetacea
- SUBORDER: Odontoceti
- FAMILY: Delphinidae
- GENUS: Tursiops
- SPECIES: truncatus



Bottlenose dolphins, the genus Tursiops, are the most common and well-known members of the family Delphinidae, the family of oceanic dolphin. 22Bottlenose dolphins live in groups typically of 10–30 members, called pods, but group size varies from single individuals up to more than 1,000. The common bottlenose dolphin is found in most tropical to temperate oceans; its colour is grey, with the shade of grey varying among populations; it can be bluish-grey, brownish-grey, or even nearly black, and is often darker on the back from the rostrum to behind the dorsal fin. The dolphin's search for food is aided by the use of sonar known as echolocation: they locate objects by producing sounds and listening for the echos. Researchers have documented echolocation details, such as signal strength, spectral qualities, and discrimination, extensively. Bottlenose dolphins are capable of immediately recognizing a variety of complexly shaped objects both within the senses of vision or echolocation and, also, across these two senses. The proximity of recognition indicated that shape information records directly in the dolphin's perception of objects through either vision or echolocation, and that these precepts are readily shared or integrated across the senses. Bottlenose dolphins are also able to extract shape information, suggesting they are able to form an "echoic image" or sound picture of their targets.

Bottlenose dolphins range in lengths from 6.0 to 12.5 ft (1.8 to 3.8 m) with males slightly larger than females. Adults can weigh from 300-1400 lbs (136-635 kg). This is a long-lived dolphin species with a lifespan of 40-45 years for males and more than 50 years for females in the wild, captive dolphins generally do not live as long according to some research studies. Bottlenose dolphins are found in temperate and tropical waters around the world. There are coastal populations that migrate into bays, estuaries and river mouths as well as offshore populations that inhabit pelagic waters along the continental shelf. Based on a number of studies of near shore populations, Bottlenose dolphins seem to live in relatively open societies. Mother and calf bonds and some other associations may be strong, but individuals may be seen from day-today with a variety of different associates. Group size is often less than 20 near shore; offshore groups of several hundred have been seen.

Dolphin brains possess three characteristics, which underlie sophisticated intelligence in all mammals, including humans. These are

1. large size – both in absolute terms and relative to body size,
2. an expanded and complex neocortex, and
3. A well-developed limbic and paralimbic system for processing emotions, social relationships and perceptions, and other high-level capacities related to awareness of self and other.

Figure 48 : Bottle Nose Dolphin

3.4. WHALE SHARK

The whale shark (*Rhincodon typus*) is a slow-moving filter-feeding carpet shark and the largest known extant fish species. The largest confirmed individual had a length of 12.65 m (41.5 ft) and a weight of about 21.5 t (47,000 lb). Unconfirmed claims of considerably larger individuals, over 14 m (46 ft) long and weighing at least 30 t (66,000 lb), are not uncommon. The whale shark holds many records for sheer size in the animal kingdom, most notably being by far the largest living non-mammalian vertebrate. It is the sole member of the genus *Rhincodon* and the only extant member of the family Rhincodontidae (called *Rhiniodon* and Rhinodontidae before 1984), which belongs to the subclass Elasmobranchii in the class Chondrichthyes. The species originated about 60 million years ago.

The whale shark is found in open waters of the tropical oceans and is rarely found in water below 22 °C (72 °F). Modelling suggests a lifespan of about 70 years, but measurements have proven difficult.[5] Whale sharks have very large mouths and are filter feeders, which is a feeding mode that occurs in only two other sharks, the mega mouth shark and the basking shark. They feed plankton and are not known to pose a threat to humans.

The whale shark inhabits all tropical and warm-temperate seas. The fish is primarily pelagic, living in the open sea but not in the greater depths of the ocean, although it is known to occasionally dive to depths of as much as 1,800 metres (5,900 ft).

Figure 49 : Whale Shark

Conservation Status:

There is currently no robust estimate of the global whale shark population. The species is considered endangered by the IUCN due to the impacts of fisheries, bycatch losses, and vessel strikes, combined with its long life span and late maturation.[2] It is listed, along with six other species of sharks, under the CMSMemorandum of Understanding on the Conservation of Migratory Sharks. This species was also added to Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 2003 to regulate the international trade of live specimens and its parts.

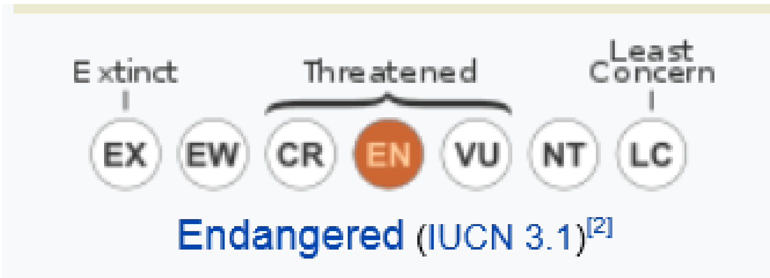


Figure 50 : Conservation Status of Whale Shark

3.5. TIGER SHARK

The tiger shark (*Galeocerdo cuvier*) is a species of requiem shark and the only extant member of the genus *Galeocerdo*. Commonly known as the "Sea Tiger", the tiger shark is a relatively large macropredator, capable of attaining a length over 5 m (16 ft 5 in). It is found in many tropical and temperate waters. It is especially common around central Pacific islands. Its name derives from the dark stripes down its body which resemble a tiger's pattern, which fade as the shark matures.

The tiger shark is a private, mostly nocturnal hunter, and is notable for having the widest food spectrum of all sharks, consuming a variety of prey ranging from crustaceans, fish, seals, birds, squid, turtles, and sea snakes to dolphins and even other smaller sharks. The tiger shark has been known to eat inedible, man-made objects that linger in its stomach, and it has a reputation as a "garbage eater".

The tiger shark commonly attains a length of 3.25–4.25 m (10 ft 8 in–13 ft 11 in) and weighs around 385–635 kg (849–1,400 lb). Sometimes, an exceptionally large male tiger shark can grow up to 4 m (13 ft 1 in). Females are larger, and exceptionally big ones can reportedly measure over 5 m (16 ft 5 in).

Figure 51 : Tiger Shark

The tiger shark is often found close to the coast, mainly in tropical and subtropical waters throughout the world. Its behavior is primarily nomadic, but is guided by warmer currents, and it stays closer to the equator throughout the colder months. It tends to stay in deep waters that line reefs, but it does move into channels to pursue prey in shallower waters.

The skin of a tiger shark can typically range from blue to light green with a white or light-yellow underbelly. The tiger shark is often found close to the coast, mainly in tropical and subtropical waters throughout the world.[7] Its behavior is primarily nomadic, but is guided by warmer currents, and it stays closer to the equator throughout the colder months. It tends to stay in deep waters that line reefs, but it does move into channels to pursue prey in shallower waters.

Conservation status:

Several populations have declined where they have been heavily fished. Continued demand for fins may result in further declines in the future. They are considered a near threatened species due to excessive finning and fishing by humans according to International Union for Conservation of Nature

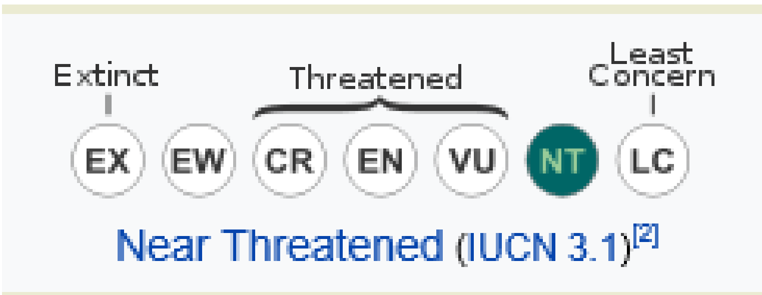


Figure 52 : Conservation Status of Tiger Shark

3.6. GREY REEF SHARK

The grey reef shark is a species of requiem shark, in the family Carcharhinidae. One of the most common reef sharks in the Indo-Pacific, it is found as far east as Easter Island and as far west as South Africa. This species is most often seen in shallow water near the drop-offs of coral reefs. The grey reef shark has the typical "reef shark" shape, with a broad, round snout and large eyes. This species can be distinguished from similar species by the plain or white-tipped first dorsal fin, the dark tips on the other fins, the broad, black rear margin on the tail fin, and the lack of a ridge between the dorsal fins. Most individuals are less than 1.9 m (6.2 ft) long. The maximum reported length is 2.6 m (8.5 ft) and the maximum reported weight is 33.7 kg (74 lb).

Grey reef sharks are fast-swimming, agile predators that feed primarily on free-swimming bony fishes and cephalopods. Their aggressive demeanor enables them to dominate many other shark species on the reef, despite their moderate size. Many grey reef sharks have a home range on a specific area of the reef, to which they continually return.

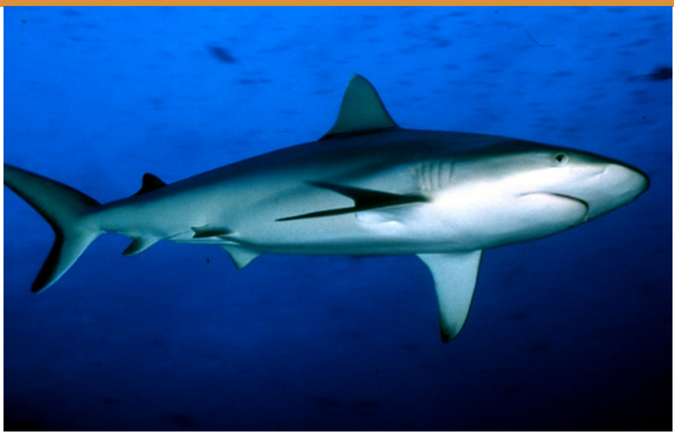


Figure 53 : Grey Reef Shark

Conservation Status: They are considered a near threatened species

Figure 54 : Conservation Status of Grey Reef Shark

13.3 TRANSPORTATION OF FISHES

Marine mammals are cosmopolitan in distribution and are often collected hundreds or even thousands of miles from their eventual destinations in research facilities and zoological parks. Over the last 20 years, specialized marine mammal transport techniques have been developed to cope with the unique physiology of marine mammals. Safe, successful transportation can be achieved with proper attention to detail and the use of appropriate technology. The level of technological detail necessary is determined by the type of marine mammal to be transported. Cetacean transport is much more complex and costly than that of other marine mammals such as sirenians, pinnipeds, sea otters (Enhydra lutra), or polar bears (Ursus maritimus).

CETACEANS:

Cetaceans spend their entire lives in water, which provides uniform support by equal distribution of pressure over their entire body? The result is an almost functional weightlessness allowing nearly effortless respiration. Furthermore, the nearly 25 times greater capacity of water to conduct heat and cold, when compared to air, rapidly dissipates cetacean metabolic heat? As a result, when removed from their free-swimming state, the two primary criteria that must be met to successfully transport cetaceans are

(1) Adequate body support for their comfort and well-being and

(2) Some sort of temperature control mechanism to assist with thermoregulation (Figures 1 and 2).

Addressing the first criterion, adequate body support techniques have been developed to allow normal breathing during transport. Cetaceans are now moved in fabric stretchers, suspended in water-filled transport units, more closely approximating the near weightlessness provided by water. Additionally, the widespread use of aircraft has allowed successful movement of cetaceans over vast distances by shortening the amount of time the cetacean is removed from the water environment.

The second criterion, adequate temperature control, is necessary because most of the cetacean's body is enclosed within a layer of thick insulating blubber. Heavily vascularized areas are present in the cetacean's pectoral fins, tail flukes, and dorsal fin. Thermoregulation is controlled through constriction or dilation of the peripheral vessels in these areas?' As previously mentioned, cetaceans are less able to dissipate excess heat when removed from the water due to the lower heat conductivity of air. Thermoregulatory assistance can be provided in several ways. If the cetacean is suspended within a water-filled container, the water temperature can be lowered through the addition of ice. Additionally, during air or enclosed-truck transport, the interior cabin temperature can be lowered to assist the cetacean with thermoregulation. Overland cetacean transports in open trucks are best conducted at night or on overcast days to prevent sunburn and provide, hopefully, lower air temperatures.

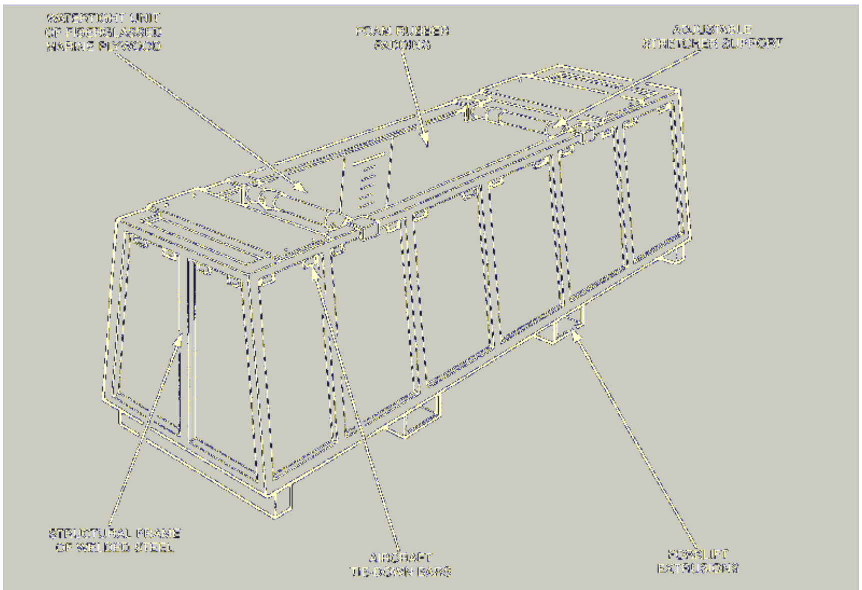


FIGURE 1. White whale (*Delphinapterus leucas*) transport unit.

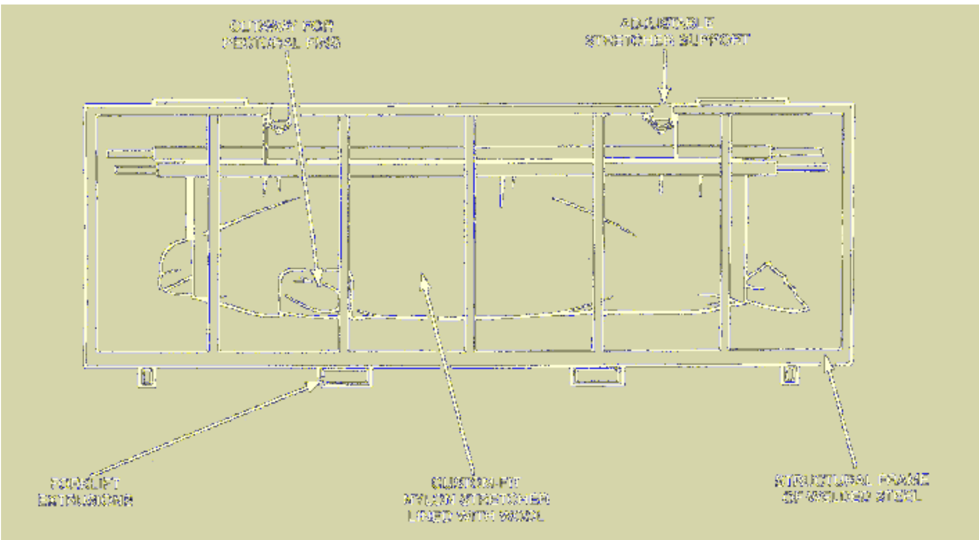


FIGURE 2. Cutaway view of white whale within transport unit.

Several of the first cetacean transports encountered difficulties; Equipment-related failures were also common in the early days of cetacean transport. Most of these failures can be avoided through proper planning and thorough preparation. In the face of the possibility of such unexpected problems, one should always have alternative plans to ensure the welfare of the animals being transported. Plans include adequate personnel and equipment to either return cetaceans to holding facilities should the transport be aborted, or to care for the animals should an emergency landing become necessary at an unexpected location.

Animal health problems resulting from early unsophisticated cetacean transports included muscular stiffness upon return to water, depression of appetite, anaemia as a result of abrasions, pressure necrosis, and respiratory infections. These can be avoided entirely by the improved transport techniques used today, which allow the cetacean lateral and vertical flexion. Abrasions and pressure necrosis are now avoided through the use of properly fitted stretchers and proper positioning within the stretcher and transport unit. Modern rapid transport has decreased or eliminated the previously common use of antibiotics and corticosteroids for the prevention and treatment of transport-related respiratory infections.

Important factors influencing the success of any cetacean transport are proper support equipment, well-trained personnel, and strict attention to logistical details. In all cases, it is advisable to have backup equipment available or to make arrangements to obtain backup equipment on short notice.

Prior to transport, a thorough assessment of the health status of the cetacean must be made.Such an assessment should include behavioural observations, a physical examination, haematological examination, and, if possible, urinalysis. Cetaceans are generally fasted for a 24-h period prior to shipment to minimize the volume of body wastes discharged into the transport container. Fasting may also reduce the incidence of regurgitation during transit (Figures 3 and 4).

Simplistically, the cetacean transport consists of: removing the cetacean from the water in a fabric stretcher; suspension of the stretcher in a water-containing transport unit; transport; and safe release into new quarters. The initial step in cetacean transport is the lifting of the whale or dolphin from its pool or holding facility in a custom-fitted stretcher made of soft material; generally either nylon or canvas. These stretchers can be lined with wool or chamois if desired. Stretchers must be constructed according to accurate measurements of the body of the individual cetacean to ensure proper fit and provide equal distribution of body weight along the stretcher.

Paired openings in the stretcher allow the pectoral fins to extend in an unrestricted, natural position Steel poles supporting the stretcher must be sturdy enough to support the weight of the cetacean, even if the weight suddenly shifts. The pole ends should be rounded or covered with caps to eliminate sharp edges. Use of a crane is required to safely lift most cetaceans from the water due to their weight. Cetaceans may move when lifted from the water, and crane capacity should be specified with a 100% safety factor, based on the weight of the animal and the reach of the boom. Hydraulic cranes are preferred over mechanical cranes due to greater operational smoothness.

Fitted in its custom stretcher, the cetacean is lowered into a watertight transport unit of appropriate size. Transporters currently in use at Sea World are constructed of fiberglass-lined marine plywood, reinforced and protected by a steel frame. Once positioned within the transport unit, sufficient water is added to submerge the lower 2/ 3 to 3/4 of the body of the animal. Suspension in water provides cooling and buoyancy, permitting exertion-free respiration throughout transport. Ice may be added either directly adjacent to the animal's skin or into various other areas within the transport unit. The melting ice keeps both the animal and the water cool. Recom-mended water temperature in killer whale transport units is below 7.2°C, while smaller cetaceans are more comfortably transported in 12° to 15°C water (Appendix 1).

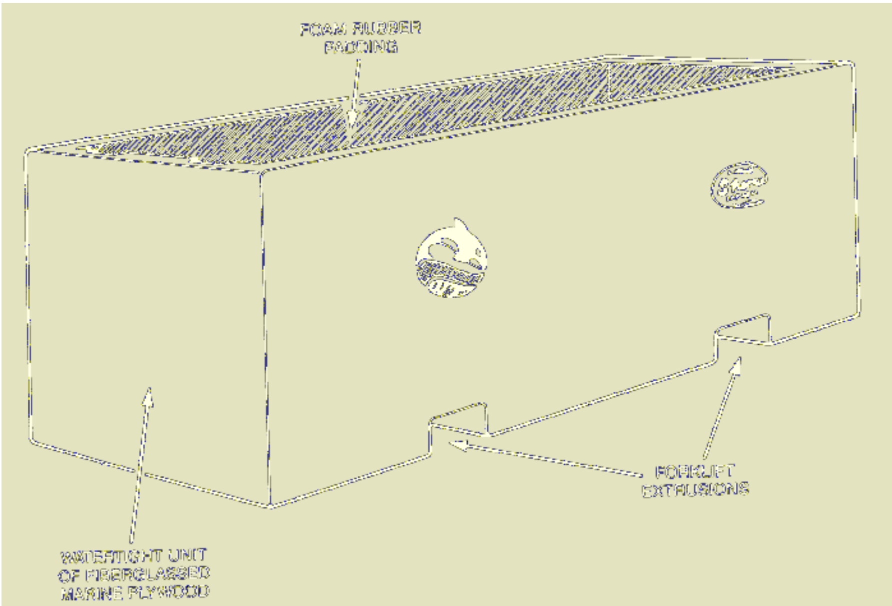


FIGURE 3. Bottlenosed dolphin (*Tursiops truncatus*) transport unit.

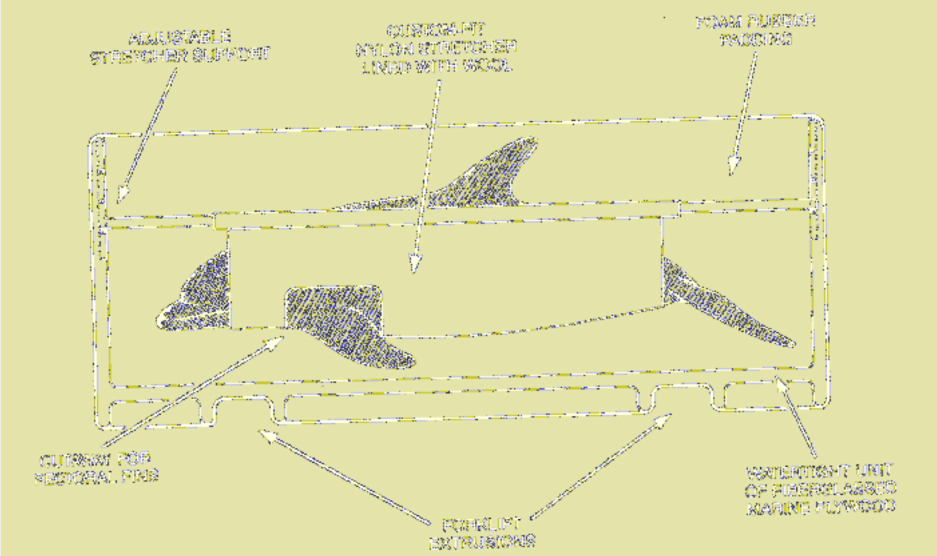


FIGURE 4. Cutaway view of bottlenosed dolphin within transport unit.

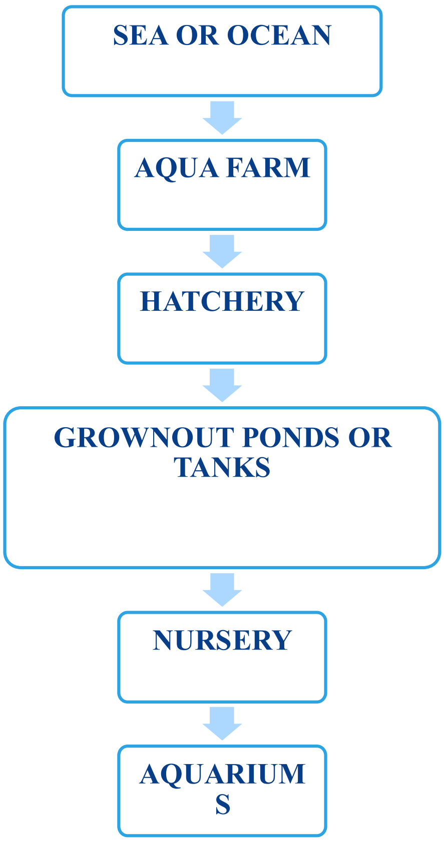
The majority of recent long-distance cetacean transports have involved the use of aircraft. Large cargo aircraft are utilized, due to the size and weight of the cetaceans and transport units. The aircraft must have provisions to lock the load safely inside the plane. Only freshwater should be used within transport units due to the extremely corrosive nature of seawater on aircraft systems.

Large cetacean transport units should be designed and constructed to be alternatively lifted by a crane, as cranes seem more readily available on short notice. Once on board, ambient air temperature is controlled and is usually maintained between 4.4° and 10.0°C, again as an aid to thermoregulation.

Appropriate equipment for unloading and ground transport is necessary at the destination airport. Such equipment should be in position at the airport prior to the arrival of the aircraft to avoid delays. Upon arrival at the poolside destination, the cetacean still suspended in its fabric stretcher is removed from the transport unit, lowered into a pool of water, and released. Such pools need not be shallow nor small, but plans and equipment should be available in case the transported animal needs assistance following release or in subsequent days. Animals should remain under continual observation for at least the first 24 h following transport. Respiratory rates should be recorded hourly and frequent attempts made to feed the just transported cetaceans. Follow-up physical examinations and haematological examination are prudent within the week following arrival, or sooner if problems arise.

FRESH WATER FISHES

1. The fresh water fishes are first caught and transported to the nearest aqua farming or aqua farm.
2. Then the specific fishes are chosen and put into the tanks.
3. The fish are then segregated and put into the nursery or a hatchery.
4. Hatchery is a place where fishes are put to breeding artificially.
5. Then the fishes are transported to specific exhibition areas or aquariums.
6. These aquariums can even choose to have their own nursery farms and hatchery.
7. These places are usually situated near water bodies.



Flow chart showing transportation process of fresh water fish transport

13.4 BEHAVIOUR PATTERN

1. **Behaviour pattern of marine mammals**
2. **Behaviour pattern of small fishes**

1. BEHAVIOUR PATTERN OF MARINE MAMMALS

a. Cetaceans - dolphins and whales

Social Groupings, Mating, and Maternal Behaviour

People believe that between man and the **whales and dolphins** there is a mystical bond. The dolphin family exhibit many types of social behaviours ranging from family like structure within a group to the inclusion of outsiders into that family pod. Up to a certain point they will readily incorporate human beings into their herds. The phenomenon of including humans into the social group or pod can be observed in the wild as well as in captivity.

In the captive environment dolphins are extremely well adapted to learning and being trained. This behaviour may be based on several factors such as their lack of a natural enemy, their apparent lack of timidity, or their overall social grouping behaviour.

For most oceanarium the trainability of these animals have led to them becoming a popular attraction for tourists; however, their trainability and ease of acclimation to humans makes them ideal candidates for scientific study.

The killer whale, a member of the dolphin family, exhibits social groupings as well. The mating habits of the killer whale are a reflection of the animal's social habits and lifestyle. Females and young may stay slightly apart from the bachelors and bulls. Most killer whales give birth to a single calf per pregnancy and "the gestation period of the killer whale is 11-12 months. The killer whale calf is about eight feet long at birth and weights an estimated four hundred pounds. The young calf stays with its mother for the first part of its life and the mother *orca* may become violent in defence of the calf. The killer whale is seen inhabiting a wide range of coastal waters.

Figure 55 : Group of Killer Whale **Figure 56 : Socialized Group of Dolphins**

Communication and Language

That dolphins and other aquatic cetaceans communicate with each other is without a doubt a fact. The process of how this communication takes place is still being studied and is not completely understood at this time. However, there is evidence of this communication in the behavioural characteristics and physical make-up of the oceanic creatures. Communication amongst these animals goes much further than mere signalling; researchers have found that most cetaceans use a series of calls and songs that are evidence in communication.

These calls and whistles have further been analysed and researchers have classified these sounds as odontocete sounds. Odontocete sounds include three major classes: clicked signals, burst pulse signals, and pure tone signals. In different species of the dolphin family these clicks may serve a variety of purposes. The animals ability to use these signaling clicks during obstacle avoidance has led researchers to question how these animals orient themselves in space.

Through a series of experiments researchers have discovered that dolphins have a highly adept ability to determine direction of calls underwater. Directional hearing is only part of the process involved in the ability of these underwater creatures to orient themselves in space. The process used in submarine detection is called sonar. it has been established that the two principles embodied in submarine-detection devices (tone duration and frequency modulation) are present in the supersonic calls of dolphins. So for the present we can rightly assume that whales [and dolphins] orient themselves in space through some sort of sonar.

b. sharks

WHALE SHARKS - Despite its size, the whale shark does not pose significant danger to humans. Whale sharks are docile fish and sometimes allow swimmers to catch a ride. Younger whale sharks are calm and can play with divers. Neither mating nor pupping of whale sharks has been observed.

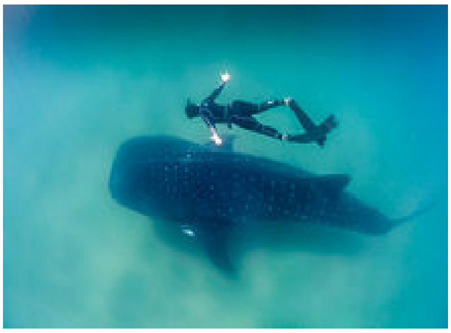


Figure 57 : Swimming alongside an adult free divers

The eggs remain in the body of the female. Females give birth to live young which are 40 to 60 cm (16 to 24 in) long. Evidence indicates the pups are not all born at once, but rather the female retains sperm from one mating and produces a steady stream of pups over a prolonged period.[at] the age of 30 they reach sexual maturity and their lifespan is an estimated 70 to 100 years.

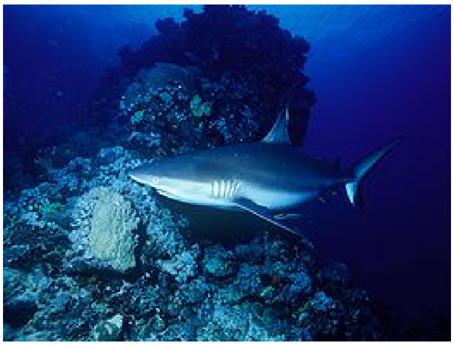


Figure 58 : Grey Reef Sharks become more active as night approaches

TIGER SHARK - Males reach sexual maturity at 2.3 to 2.9 m (7.5 to 9.5 ft) and females at 2.5 to 3.5 m (8.2 to 11.5 ft). Females mate once every three years. Life span of tiger sharks live is unknown, but they can live longer than 12 years.

Figure 59 : Grey Reef Shark often group together during the day

The tiger shark is reported to be responsible for a large percentage of fatal shark bite incidents, and is sometimes regarded as one of the most dangerous shark species. Human contacts with tiger sharks in Hawaiian waters have been shown to increase between September and November, when tiger shark females are believed to migrate to the islands to give birth.

GREY REEF SKARK - Grey reef sharks are active at all times of the day, with activity levels peaking at night. Grey reef sharks from different parts of the reef exhibit different social and ranging behaviours. Sharks on the outer ocean reefs tend to be nomadic, swimming long distances along the reef, while those around lagoon reefs and underwater pinnacles stay within defined daytime and night-time home ranges. The number of sharks per group differs from year to year.

Grey reef sharks are often curious about divers when they first enter the water and may approach quite closely, though they lose interest on repeat dives. There have been several known attacks on spear fishers.

2. BEHAVIOUR PATTERN OF SMALL FISHES

School of fishes:

This is an important aspect, which regulates the designing aspect to size and functioning of the tanks. . Experiments on the behaviour of young fishes have confirmed that the schooling is innate and is perfected in the first stage of life. A fish, which becomes isolated from the school when young, has difficulty in reinserting itself. Taking about the design the design will not have to cater to fish but to a particular group of fishes, which act as one.

The importance of colour

Pelagic fishes enjoy a living in a concealing system that uses the effect of light that falls on the bodies of the fish from above. If the light distribution was normal, the back would be light and the belly would be dark. In such a case the fish would be seen even in a way off.


Figure 60 : School of FishesFigure 61 : Mandarin Fish

Mimicry and defence

Some species of fishes have a considerable case to adapt color to their environment. . An experiment to control the advantages of such color adaptations were carried out with gambesons that had been kept in light and dark colored tanks. The two predators were kept in tanks of opposite colors to that assumed, together to an equal number of gambesons of the same color as the tank. Then the two predators were put into the tanks and soon they began to feed on the gambesons. The surviving gambesons, which were of the same color as that of the bottom of the tank soon out numbered the others, remaining in the ratio of 3:1. The advantage of their colouring is thus obvious necessitating the design of the tank in relevance of the fishes, which show such properties.

Symbiosis and survival

One way of surviving in a hostile environment is to seek protection near another huge animal or one endowed with an understanding means of defence. Usually the protection is reciprocated with services of various kinds as in the case we have already seen of cleaner fish, labroids.

Fishes and sound

Fishes are able to utilize acoustical property of water to catch the vibrations emitted by the other fishes and to distinguish predators from harmless fishes.

The movement of fishes in water

All the fishes can move in water but do all move in the same manner. Their shape is important for swimming purpose but their internal structure is even more important. It is this that limits them to a particular movement. Two important observations can be made; the main part of the movement is not carried out by the fins but by the latter part of the body. The movement is a result of a series of rhythmic flexures in the body. Analysing these flexures further we see that they are made by waves running along the body. The extent of these waves increases little by little until they reach as far as the head and the tail. The motor that makes them swim in the series of muscular segments on either side of the ventral column. Fish also need to manoeuvre in their surroundings to be able to perform turns and stops and to make certain movements in the reverse. Their fins carry out this.

Coloration and fish

Many bottom living fishes, such as flat fishes, camouflage themselves by taking the color and the pattern of the substrate. The color change is under the control of the hormones and the nervous system. Almost all the fishes that live in the upper water layers have pale silvery sides to their body. Deep-sea fishes are dark while those living among the seaweeds have grown green or brown protective coloration. Finally many attain nuptial coloration during the breeding period and this may serve to attract a partner or to drive away rivals.

Figure 62 : Mimicry of Camouflage

Figure 63 : mimicry of Frog Fish

01 CORAL REEF AND KELP FOREST

6.1 INTRODUCTION TO CORAL REEF

Deep in the waves there lies a coral grave where the purple mullet and the goldfish rave where the sea flowers spreads its leaves of blue that never are bathed in the morning dew ...j.u.pereival

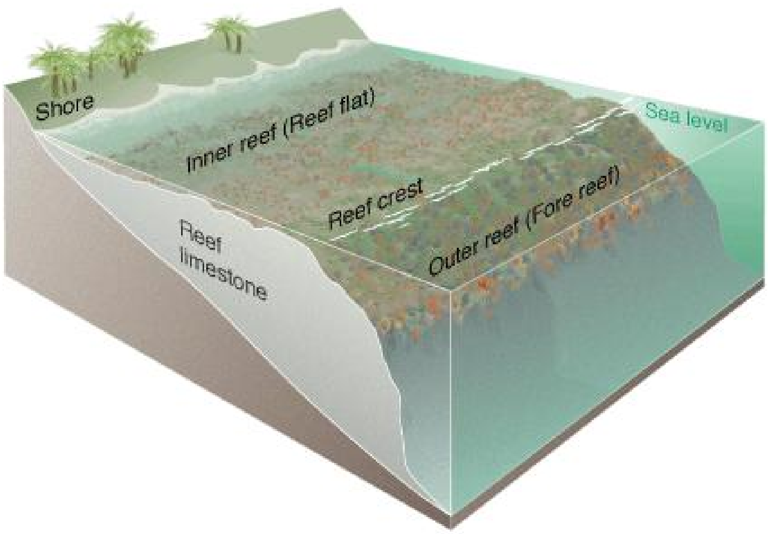
Coral reefs are diverse underwater ecosystems held together by calcium carbonate structures secreted by corals. Coral reefs are built by colonies of tiny animals found in marine waters that contain few nutrients. Most coral reefs are built from stony corals, which in turn consist of polyps that cluster in groups. The polyps belong to a group of animals known as Cnidaria, which also includes sea anemones and jellyfish. Unlike sea anemones, corals secrete hard carbonate exoskeletons which support and protect the coral polyps. Most reefs grow best in warm, shallow, clear, sunny and agitated waters .Often called "rainforests of the sea"; shallow coral reefs form some of the most diverse ecosystems on Earth. They occupy less than 0.1% of the world's ocean surface, about half the area of France, yet they provide a home for at least 25% of all marine species, including fish, mollusks, worms, crustaceans, echinoderms, sponges, tunicates and other cnidarians. They are most commonly found at shallow depths in tropical waters, but deep water and cold water corals also exist on smaller scales in other areas.

Healthy coral reefs

Coral reefs deliver ecosystem services to tourism, fisheries and shoreline protection. The annual global economic value of coral reefs is estimated between US$29.8-375 billion. However, coral reefs are fragile ecosystems, partly because they are very sensitive to water temperature. They are under threat from climate change, oceanic acidification, blast fishing, cyanide fishing for aquarium fish, sunscreen use, overuse of reef resources, and harmful land-use practices, including urban and agricultural runoff and water pollution, which can harm reefs by encouraging excess algal growth.

6.2 ZONES

Coral reef ecosystems contain distinct zones that represent different kinds of habitats. Usually, three major zones are recognized: the fore reef, reef crest, and the back reef (frequently referred to as the reef lagoon). All three zones are physically and ecologically interconnected. Reef life and oceanic processes create opportunities for exchange of seawater, sediments, nutrients, and marine life among one another. Thus, they are integrated components of the coral reef ecosystem, each playing a role in the support of the reefs' abundant and diverse fish assemblages. Most coral reefs exist in shallow waters less than 50 m deep. Others are found in the deep ocean surrounding islands or as atolls, such as in the Maldives.



The three major zones of a coral reef: the fore reef, reef crest, and the back reef

6.3 TYPES

The three principal reef types are:

Fringing reef	Directly attached to a shore, or borders it with an intervening shallow channel or lagoon.
Barrier reef	reef separated from a mainland or island shore by a deep channel or lagoon
Atoll reef	more or less circular or continuous barrier reef extends all the way around a lagoon without a central island

Other reef types or variants are:

Patch reef	common, isolated, comparatively small reef outcrop, usually within a lagoon or embayment, often circular and surrounded by sand or seagrass
Apron reef	short reef resembling a fringing reef, but more sloped; extending out and downward from a point or peninsular shore
Bank reef	linear or semicircular shaped-outline, larger than a patch reef
Ribbon reef	long, narrow, possibly winding reef, usually associated with an atoll lagoon
Table reef	isolated reef, approaching an atoll type, but without a lagoon
Habili	reef specific to the Red Sea; does not reach the surface near enough to cause visible surf; may be a hazard to ships (from the Arabic for "unborn")
Microatoll	community of species of corals; vertical growth limited by average tidal height
Cays	small, low-elevation, sandy islands formed on the surface of coral reefs from eroded material that piles up, forming an area above sea level; occur in tropical environments throughout the Pacific, Atlantic and Indian Oceans (including the Caribbean and on the Great Barrier Reef and Belize Barrier Reef), where they provide habitable and agricultural land
Seamount or guyot	formed when a coral reef on a volcanic island subsides; tops of seamounts are rounded and guyots are flat; flat tops of guyots, or *tablemounts*, are due to erosion by waves, winds, and atmospheric processes

A small atoll in the Maldives **Inhabited cay in the Maldives**

6.4 BIODIVERSITY

Coral reefs form some of the world's most productive ecosystems, providing complex and varied marine habitats that support a wide range of other organisms. Reefs are home to a large variety of animals, including fish, seabirds, sponges, cnidarians (which includes some types of corals and jellyfish), worms, crustaceans (including shrimp, cleaner shrimp, spiny lobsters and crabs), mollusks (including cephalopods), echinoderms (including starfish, sea urchins and sea cucumbers), sea squirts, sea turtles and sea snakes. Aside from humans, mammals are rare on coral reefs, with visiting cetaceans such as dolphins being the main exception. A few of these varied species feed directly on corals, while others graze on algae on the reef.

Over 4,000 species of fish inhabit coral reefs

6.5 CONDITIONS REQUIRED FOR CORAL DEVELOPMENT

1. Corals are confined to clear water less than 4000ft (122Mts) deep in nature
2. The temperature should not go below 65 degrees F. (18 degree C).
3. The water should have abundance of plankton to provide a food supply for the corals.

6.6 DANGERS OF SWIIMING IN CORAL REEFS

It's a pleasure to swim in clear, warm tropical waters and to take in all the color and life along reefs and coastlines. But these areas can be just as dangerous as swimming in the wide open ocean. Most people think sharks are the only thing to worry about in the ocean. In fact, they may be the least of your concerns in certain parts of the world's oceans. The dangers along reefs and coastlines can be beautiful, surprising and potentially deadly.

The main reason why visitors fail to have good luck at the reefs is probably tear. Undoubtedly some danger does exits. Scuba divers have the constant fear of dangerous fish which are capable of wounding them. Minor discomfort may come by brushing an arm or leg against fine corals or some type of sea anemone or by stepping on sharp spines of sea urchins. Perhaps the most common trouble in swimming around corals for close observation is being pushed by a wave or a current against the sharp edges of many corals.

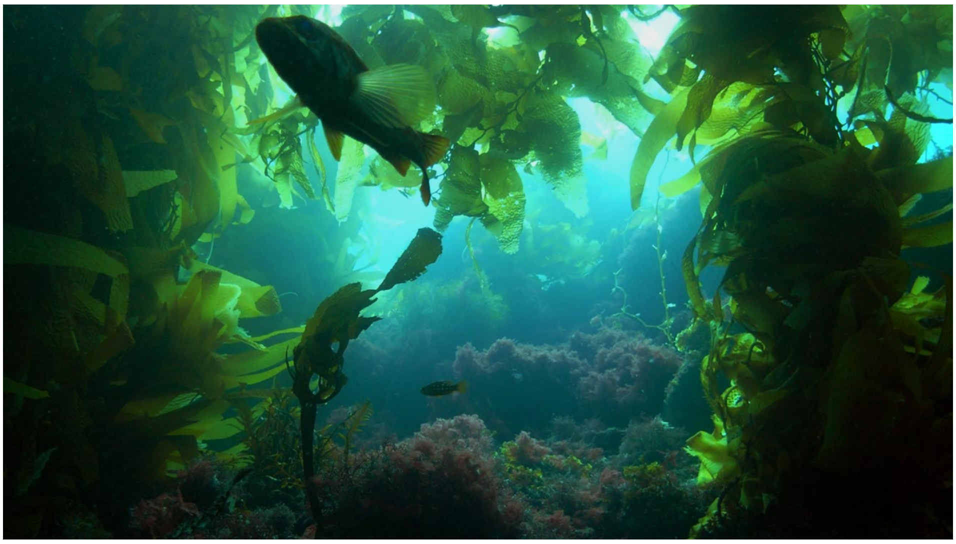
Scuba divers along great barrier reefs

6.7 KELP FOREST

Kelp Forests are underwater ecosystems formed in shallow water by the dense growth of several different species known as kelps. Though they look very much like plants, kelps are actually extremely large brown algae. Some species can reach heights (underwater) of 150 feet (45 m), and under ideal physical conditions, kelp can grow 18 inches (45 cm) in a single day! As a result of this incredible growth, kelp forests can develop very quickly in areas that they did not previously exist.

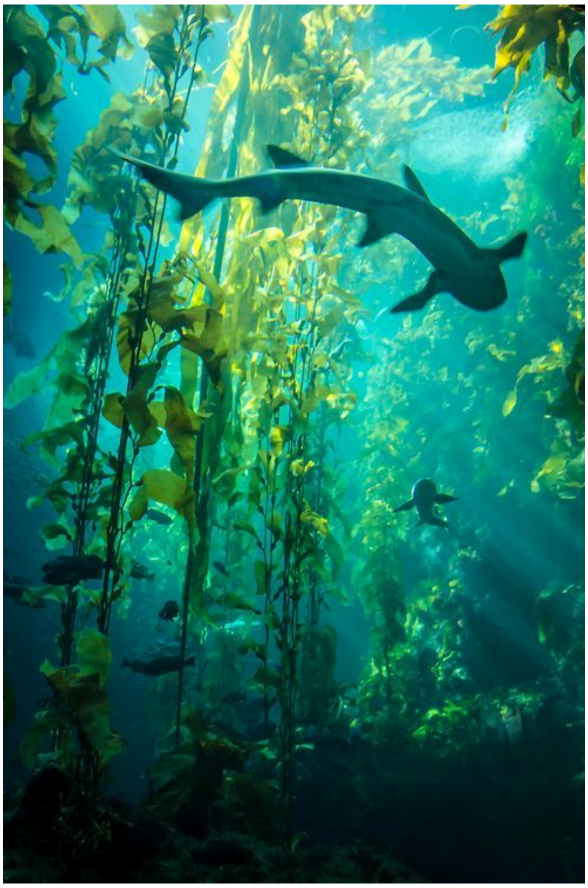
Kelp forests are underwater areas with a high density of kelp. They are recognized as one of the most productive and dynamic ecosystems on Earth. Smaller areas of anchored kelp are called **kelp beds**. Kelp forests provide a unique, three-dimensional habitat for marine organisms and are a source for understanding many ecological processes. Kelp forests can influence coastal oceanographic patterns and provide many ecosystem services.

However, the influence of humans has often contributed to kelp forest degradation. Of particular concern are the effects of overfishing near shore ecosystems, which can release herbivores from their normal population regulation and result in the overgrazing of kelp and other algae. This can rapidly result in transitions to barren landscapes where relatively few species persist.



Kelp forest ecosystem

A wide range of sea life uses kelp forests for protection or food, including fish, particularly rockfish, and many invertebrates, such as amphipods, shrimp, marine snails, bristle worms, and brittle stars. Many marine mammals and birds are also found, including seals, sea lions, whales, sea otters, gulls, terns, snowy egrets, great blue herons, and cormorants, as well as some shore birds. The environmental factors necessary for kelp to survive include hard substrate (usually rock or sand), high nutrients (e.g., nitrogen, phosphorus), and light. With respect to kelp forests, major issues of concern include marine pollution and water quality, kelp harvesting and fisheries, invasive species, and climate change.



Sharks in kelp forest

07 CURRENT SCENARIOS IN INDIA

13.5 EXISTING OCENARIUM AND AQUARIUMS IN INDIA

SR. NO.	NAME	CITY	STATE
1.	Bagh-e-Bahu Aquarium Notes: This 222 m long aquarium is within the Bahu Fort complex and is India's second largest underground aquarium-cum-awareness centre.	Jammu	Jammu and Kashmir
2.	Bangalore Aquarium	Bangalore	Karnataka
3.	Calcutta Aquarium	Kolkata	West Bengal
4.	Central Institute of Freshwater Aquaculture (CIFA) Aquarium	Bhubaneswar	Odisha
5.	Dr. A. M. Michael Aquarium, Kerala University of Fisheries and Ocean Studies	Panangad, Kochi	Kerala
6.	District Tourism Promotion Council (DTPC) Aquarium	Kozhikode	Keral a
7.	Jagdishchandra Bose Aquarium	Surat	Gujarat
8.	Jawahar Aquarium	Mussoorie	Uttarakhand
9.	Kankaria Aquarium	Ahmedabad	Gujarat
10.	Kollam Aquarium	Kollam	Kerala
11.	Lal Bagh aquarium	Bangalore	Karnatak a
12.	Machhli Ghar	Bhopa l	Madhya Pradesh
13.	MARC Aquarium	Digha	West Bengal
14.	Marine Biological Research Station	Ratnagiri	Maharashtra

15.	Marine Life Aquarium	Chennai	Tamil Nadu
16.	Matsyadarsini Aquarium	Visakhapatnam	Andhra Pradesh
17.	Nandankanan Zoo Aquarium	Bhubaneswar	Odisha
18.	Sanjay Gandhi Jaivik Udyan	Patna	Bihar
19.	Star aquarium	Karunagappalli	Kerala
20.	Taraporewala Aquarium	Mumbai	Maharashtra
21.	Sambhaji Park Aquarium	Pune	Maharashtra
22.	Travancore Royal Aquarium	Trivandrum	Uttar Pradesh
23.	ICAR-NBFGR Ganga Aquarium	Lucknow	Uttar Pradesh
24.	Varkala Aquarium Notes: The four-storey aquarium is situated on the beach along the Prawn Hatchery at Thiruvambady(Odayam - Varkala). The Agency for Development of Aquaculture, Kerala (ADAK) was responsible for the 3500 sq ft aquarium showcasing wonders of the water world.	Trivandrum	Kerala

Despite having a vast coastline and muptiple issues related to ocean and marine life, There are only 24 no. of aquariums in india. Currently there is **NO OCENARIUM IN INDIA**. Due to increasing issues regarding marine life; government of inida is now realizing the importance of ocean and marine life. to conserve ocean and endangered marine species government is proposing some oceanarium in major cities of india.

13.6 PROPOSED OCENARIUM IN INDIA

a) Kerala

a.1) Kochi Oceanarium

a.2) Dolphin Park

b) Maharashtra

b.1) Sea World, Sindhudurg

b.2) Water World at Mahalaxmi Race Course, Mumbai (Dolphin Park With Underground Aquarium)

b.3) Expansion of Taraporewala Aquarium, Mumbai On Location Or Worli Dairy

c) New Delhi

Blue Planet Aquarium or Water World, Grand Venice Hotel, Greater Noida

Brief profiles based on recent media reports (annexed) on these proposals, put forth currently by Kerala, Maharashtra and New Delhi are presented as follows:

a) Kerala

No. Of Projects - 2

a.1) Proposed Project Name – Kochi Oceanarium

The proposed Oceanarium is envisaged to be a state of the art Oceanarium set in 36.5 acres of possible reclaimed land and is earmarked for this project at Puthu Vypeen, Kochi. The consultant, M/s Mahindra Consulting Engineers Ltd. has completed the feasibility study and submitted the Detailed Feasibility Report. A Special Purpose Company has been registered for development of the project viz. Kerala Oceanic & Marine Park Ltd. The project is proposed to be implemented on Public Private Partnership (PPP) mode. The Oceanarium for its sustained operation would require a strong R&D and technical support in the area of marine biology. It proposes to enable this with the assistance from Ministry of Earth Sciences, GOI. This facility would be established as a separate entity and the cost for this is estimated at Rs.130 Crores.

The services of R&D centre will be made available to the Oceanarium on cost plus basis. The proposed development components for the Oceanarium complex would include the following, aquarium, touch tanks, thematic pavilions, shark tank, lagoon, and a polar pavilion. The Main tank containing Aqua Terrarium, Under water vision, barrier Reef, Deep Sea Tunnel will have a capacity of 8000 cubic meters. The shark tank will have a capacity of 1230 cubic meters.

This project is reportedly being executed through the State Fisheries Resource Management Society (FIRMA). Mangroves, which reportedly densely cover the region, are vulnerable to such intensive infrastructural development projects according to environmental experts. Despite the fact that the Union Ministry of Environment and Forests has made it categorically clear that land reclamation, building bunds, disturbing the natural course of sea water, destruction of mangroves and construction and developmental activities are prohibited in areas coming under the Zone One of the Coastal Regulation Zone, recent reports suggest the possibility that the state government may have given in-principle approval to the establishment of this project.

Any such approval must be reversed to ensure protection of both animals and natural resources.

a.2) Proposed Project Name – Dolphin Park

This proposal is slated to be Asia's largest dolphinarium. It is proposed to be a feature of the entertainment zone that is a part of the overall Marine Drive Phase II development initiative allegedly under the Greater Cochin Development Authority (GCDA). The GCDA chaired by Mr. N. Venugopal is currently considering a proposal submitted by a company called Initor

Projects, reportedly based in British Virgin Islands and the Middle East, which claims to have expertise in setting up dolphinaria globally.

The proposal mentions that Initor Projects is able to source wild-caught dolphins, rental dolphins or even captive bred dolphins or dolphins being held in captivity elsewhere. Experts believe that is difficult to establish the authenticity of a captive bred dolphin given the commercial nature of the industry, and deem that most dolphins kept in captivity are considered to be more often than not, sourced through wild capture. The project is estimated to be executed through a public-private partnership model at a cost of more than 20 crores with each dolphin costing an additional 1,55,000 – 2,95,000 USD each.

The developers propose to hold dolphin shows or performances thrice a day, with international staff and possibility of additional seal performance shows. News reports released in October 2012 (annexed) also report that a team from Dubai comprising of alleged experts from the UK and Russia who were involved in setting up Dolphin parks in the Middle East will also be assessing the site. The proposal further states that interaction programmes will be conducted between the captive dolphins that are marine mammals as well as carnivorous predators and the general public.

b) Maharashtra

No. Of Projects - 3

b.1) Proposed Project Name – Sea World, Sindhudurg

The Maharashtra government is reportedly planning to set up a new ocean theme park and Dolphinarium to be built on the Malvan coastline in Sindhudurg. It includes plans for a Dolphin stadium, theme restaurants, water sport areas, golf course, Antarctica attraction and an underwater studio. The 500-600 acre-sized theme park, is expected to cost about Rs 510 crore and was presented to the cabinet by tourism minister Chhagan Bhujbal last year. The facility allegedly intends to display corals, dolphins, seals, penguins and a host of other marine creatures. The Maharashtra state government hopes the project will generate tourism revenue and increase employment opportunities for the region. It is believed that a detailed project report (DPR) is being prepared by Dr. Sarang Kulkarni (Science and Technology Centre, Pune).

b.2) Proposed Project Name – Water World At Mahalaxmi Race Course, Mumbai (Dolphin Park With Underground

Aquarium)

This project proposal allegedly intends to promote Dolphin-assisted “therapy” for humans as well as display Dolphins for performances and interaction programmes to promote tourism. Such “therapy” is entirely lacking justification by health care authorities; nor can the well-being of dolphins be assured; The Animal Welfare Board of India has not approved any such “use” of animals under any circumstances for dubious human “benefit.” The Mayor of Mumbai reportedly first put this suggestion forth in 2009 and the project is currently under the Commissioner of Fisheries, Mumbai and the status is unknown.

b.3) Proposed Project Name – Expansion Of Taraporewala Aquarium, Mumbai On Location Or Worli Dairy

This proposal is allegedly focused on the renovation of the famous Taraporewala Aquarium in Mumbai, by building a tunnel leading to the sea with whales and Dolphins, on the lines of Singapore and Malaysia. Other media reports suggest that the

Taraporewala Aquarium will be added to by way of a 5- star hotel and fish massage facility. Additionally, Worli Dairy is also being considered as a possible site for the Oceanarium.

c) New Delhi

No. Of Projects – 1

Proposed Project Name – Blue Planet Aquarium Or Water World, Grand Venice Hotel, Greater Noida

An aquarium and Dolphinarium is being proposed as a part of a Venice-themed tourist resort named ‘Grand Venice.’ This venture would join Bhasin Infotech & Infrastructure Pvt. Ltd (Conceived, Developed and Promoted) and Sheraton Hotels & Resorts and a Singapore-based company, Andover Leisure Pvt. Ltd. The aquarium would cover an area of 1-lakh square feet and the major exhibits would include seawater tanks for large marine life like sharks and lionfish with acrylic tunnels for the tourists to walk through. The shark enclosure would have transparent bottomed boats for looking down into the water from the surface. Sharks, Penguins, Walrus, Octopus and Dolphins would reportedly be on display and may also be used in performance.

11 CURRENT POLICY & LEGAL FRAMEWORK - to regulate import of wild animals with emphasis on cetaceans for commercial performance and captive display in India

Over the past 20 to 30 years there have been considerable criticisms against keeping animals in captivity. A number of questions have been raised as to the scientific validity of doing so. In the past animals in captivity were separated from their natural surroundings and were often being held at the cost of their lives. Zoos were often constructed with very little consideration of the behavioural welfare of the animals. The animals were often placed in cages resembling jail cells, which were constructed only with the health and happiness of the keepers and viewers in mind. The cages with concrete floors and walls were designed mainly for ease of maintenance, and display areas constructed from steel bars through which the animals were viewed.

The cetaceans, as the endearing mammals are referred to, find it hard to survive in captivity. MoEF (ministry of environment and forests) has noted. ThusMoEF (ministry of environment and forests) and CZA(central zoo authority)felt it is necessary to create a standing policy for their functioning as they houses many endangered marine species also. The policy includes general guidelines for functioning of aquariums and provide outline for general monitoring mechanisms of the marine life on public display there. The policy is also address the conservation and breeding efforts for endangered marine animals. The policy also takes care of the safety aspect of aquarium staff and people coming to visit such places.The policy also help in taking stock of the animals already present in such aquariums and the kind of facilities being provided to them.

Below are current policies and legal frameworkto regulate import of wild animals with emphasis on cetaceans for commercial performance and captive display in India:

a) Wildlife (Protection) Act, 1972

- The circular points out that under Section 2 (39) of Wild Life (Protection) Act, 1972, the dolphinarium will be categorized under the definition of a zoo. The zoo is defined as a stationary or mobile establishment, where captive animals are kept for exhibition to the public.

- As per Section 38H (1A) of the same act, a zoo is not permitted to be set up without the approval of the central zoo authority (CZA). The zoo has to be operated only after CZA grants recognition to it under Section 38H (1) of the act.
- While the zoo also needs the approval of the Supreme Court, the CZA will permit setting up a dolphinarium only if it is convinced that it will serve the purpose of protection and conservation of wildlife.
- The central government has listed Gangetic dolphin and Snub fin dolphin in schedule I and all cetacean species are listed in schedule II part I of the Wild Life (Protection) Act, 1972.

b) Foreign trade (Development and Regulation) Act 1992

- As per section 8 (1) no export or import shall be made except in accordance with the provisions of this Act, the rules and orders made there under.
- Chapter III of this Act deals with the Classification of Export & Import Items, and Live animals; Animal Products are mentioned under Schedule I & Section I of the Import Policy.

c) Foreign Trade Policy (2009-2014)

- The Foreign Trade Policy is brought out under the provisions of the Foreign Trade (Development & Regulation) Act 1992 and it regulates the import and export of all goods including wildlife.
- Import of animals and their parts andproducts for zoological parks and circuses or for research purpose may be only permitted subject to the provisions of CITESand on recommendations of the Chief Wildlife Warden of the States and Union Territories under license from the DirectorGeneral of Foreign Trade (DGFT).
- All imports andexports of wild animals and plants are permitted only through the Customs points at Mumbai, Delhi, Amritsar, Kolkata, Chennai,Cochin, and Tuticorin), governing import and export of permissible species of wildlife and wildlife products.

d) Customs Act, 1962

- Section 3(3) of the Foreign Trade (Development and Regulation) Act 1992 provides that all items (including wild Fauna & Flora) covered in the Import & Export policy will be deemed to be covered under Section 11 of the Customs Act, 1962.

- As a consequence, all cases of violation of the Import-Export Policy in general and CITES in particular, constitute an offence under the Customs Act and are dealt with by the Customs officials.
- Export or import of wild animals and their parts and products is allowed for the purpose of scientific research and exchange of animals between Zoos and is subject to licensing by the Director General of Foreign Trade (DGFT), Government of India.

e) Performance Certificate, Animal Welfare Board of India (AWBI)

- In exercise of the power conferred by Section 38 of the Prevention of Cruelty to Animals Act, 1960 Central government has framed the Performing Animals (Registration) Rules, 2001 with amendments from time to time.
- All animals that are used at or for the purpose of entertainment have to be registered with the Animal Welfare Board of India (AWBI).
- All animals that are registered must be trained subject to conditions of registration laid down under the rules.
- If the said animal species is intended for zoo facility, the Central Zoo Authority must provide the authorization. If it is intended for use as a commercial performing animal, then the State Government receives the application for the said species in compliance with the rules as laid out under the **Performing Animals Act** *(Cetaceans currently not in the two schedulesspecified in the Act)* with a copy of the application sent to the Animal Welfare Board of India (AWBI).

f) Prevention of Cruelty to Animals Act, 1960 (reference to Capture & Transport Rules)

- In exercise of the powers conferred by clause (i) of subsection (2) of Section 38 of the Prevention of Cruelty of Animals Act, 1960 (59 of 1960), the Central Government has made the Prevention of Cruelty (Capture of Animals) Rules, 1979. In exercise of the powers conferred by clause (h) of sub-section (2) of Section 38 of the Prevention of Cruelty to Animals Act,
- 1960 (59 of 1960); the Central Government has made the Transport of Animals, Rules, 1978.

<u>SCHEDULE – I</u> : ***Rare and endangered species which are totally protected***

<u>SCHEDULE – II</u> : ***'Game' species which have been given more stringent protection***

SCHEDULE SPECIES (MAMMALS)

INDIAN WILDLIFE (PROTECTION) ACT, 1972

Common Name	Scientific Name	WPA, 1972	IUCN	CITES	CMS
Beryde Whale	Balaenoptera edeni	Sch I (Part I)			
Blainville's Beaked Whale	Mesoplodon densirostris	Sch I (Part I)	DD	II	
Blue whale	Balaenoptera musculus	Sch I (Part I)	EN	I	I
Bottle-Nosed Dolphin	Tursiops truncatus	Sch I (Part I)	DD	II	II
Common Dolphin	Delphinus delphis	Sch I (Part I)			
Cuvier's Beaked Whale	Ziphius cavirostris	Sch I (Part I)			
Dwarf sperm Whale	Kogia simus	Sch I (Part I)			
False Killer Whale	Pseudorca crassidens	Sch I (Part I)			
Fin whale	Balaenoptra physalus	Sch I (Part I)			
Finless Porpoise	Neophocaena phocaenoides	Sch I (Part I)			
Fraser's Dolphin	Lagenodelphis hosei	Sch I (Part I)	DD		II
Ganges River Dolphin	Platanista gangetica	Sch I (Part I)	EN	I	
Ginko-Toothed Beaked Whale	Mesoplodon ginkgodens	Sch I (Part I)	DD	II	
Hump-backed Whale	Megaptera novaeangliae	Sch I (Part I)			
Indo-Pacific Humpback Dolphin	Sousa chinensis	Sch I (Part I)			
Irrawady Dolphin	Orcaella brevirostris	Sch I (Part I)	DD	I	II
Killer Whale	Orcinus orca	Sch I (Part I)	LR/cd	II	II
Long-snouted spinner Dolphin	Stenella longirostris	Sch I (Part I)			

Common Name	Scientific Name	WPA, 1972	IUCN	CITES	CMS
Melon-headed whale	Peponocephala electra	Sch I (Part I)			
Minke Whale	Balaenoptera acutorostrata	Sch I (Part I)			
Pan-tropical spotted Dolphin	Stenella attenuata	Sch I (Part I)			
Pygmy Killer Whale	Feresa attenuata	Sch I (Part I)	DD		
Pygmy Sperm Whale	Kogia breviceps	Sch I (Part I)			
Risso's Dolphin	Grampus griseus	Sch I (Part I)			
Rough- toothed Dolphin	Steno bredanensis	Sch I (Part I)	DD	II	
Sei whale	Balaenoptra borealis	Sch I (Part I)			
Short-finned Pilot Whale	Globicephala macrorhynchus	Sch I (Part I)			
Sperm Whale	Physeter catodon	Sch I (Part I)			
Striped Dolphin	Stenella coeruleoalba	Sch I (Part I)			

SCHEDULE SPECIES (FISHES)

INDIAN WILDLIFE (PROTECTION ACT), 1972

Fishes	Scientific Name	WPA, 1972	IUCN	CITES	CMS
Whale shark	*Rhincodon typus*	Sch I (Part IIA)	VU	II	
Knifetooth sawfish	*Anoxypristis cuspidata*	Sch I (Part IIA)	EN		
Long nosed shark / Pondicherry shark	*Carcharhinus hemiodon*	Sch I (Part IIA)			
Gangetic shark	*Glyphis gangeticus*	Sch I (Part IIA)	CR		
Speartooth shark	*Glyphis glyphis*	Sch I (Part IIA)			
Ganges stingray	*Himantura fluviatilis*	Sch I (Part IIA)			
Freshwater sawfish	*Pristis microdon*	Sch I (Part IIA)	EN		
Green sawfish	*Pristis zijsron*	Sch I (Part IIA)	EN		
Giant guitarfish	*Rhynchobatus djiddensis*	Sch I (Part IIA)	VU		
Porcupine ray	*Urogymnus asperrimus*	Sch I (Part IIA)	VU		
All sygnathidians	*Sea Horse & Pipe fishes*	Sch I (Part IIA)			
Giant grouper	*Epinephelus lanceolatus*	Sch I (Part IIA)			
Coelenterates					
Reef building corals (all Scleractinians)		Sch I (Part IVA)			
Black coral (All Antipatharians)		Sch I (Part IVA)			
Organ Pipe coral (Tubipora musica)		Sch I (Part IVA)			
Fire coral (All Millipora species)		Sch I (Part IVA)			
Sea fan (all Gorgonians)		Sch I (Part IVA)			
Sponges (All carlcareans)		Sch III			
Mollusca					
	Cassis cornuta	Sch I (Part IVB)			
	Charonia tritonis	Sch I (Part IVB)			
	Conus malneedwardsi	Sch I (Part IVB)			
	Cypracasis rufa	Sch I (Part IVB)			
Bear Paw Clam	*Hippopus hippopus*	Sch I (Part IVB)	LR/cd		
	Nautilus pompilus	Sch I (Part IVB)			

Fishes	Scientific Name	WPA, 1972	IUCN	CITES	CMS
Small Giant Clam	*Tridacna maxima*	Sch I (Part IVB)	LR/cd		
Fluted Clam	*Tridacna squamosa*	Sch I (Part IVB)	LR/cd		
	Tudicla spiralis	Sch I (Part IVB)			
	Cypraea lamacina	Sch IV			
	Cypraea mappa	Sch IV			
	Cypraea talpa	Sch IV			
	Fasciolaria trapazium	Sch IV			
	Harpulina arausica	Sch IV			
	Lambis chiragra	Sch IV			
	Lambis chiragraarthitica	Sch IV			
	Lambis crocea	Sch IV			
	Lambis millepeda	Sch IV			
	Lambis scorpius	Sch IV			
	Lambis truncata	Sch IV			
	Placenta placenta	Sch IV			
	Strombus plicatus sibbaldi	Sch IV			
	Trochus niloticus	Sch IV			
	Turbo marmospratus	Sch IV			
Echinodermata					
All Holothurians (sea cucumbers)		Sch I (Part IVC)			

01 COASTAL REGULATION CLASSIFICATION ANF DEVELOPMENT REGULATION

13.7 CLASSIFICATION OF COASTAL REGULATION ZONE

For regulating development activities, the coastal stretches within 500 meters of High Tide Line on the landward side are classified into four categories, namely:

CATEGORY I (CRZ-I):

1. Areas that are ecologically sensitive and important such as national parks/ marine parks, sanctuaries, reserve forests, wildlife habitats, mangroves, coral/ coral reefs, areas close to breeding and spawning grounds of fish and other marine life, areas of outstanding natural beauty/ historically/ heritage areas, areas rich in genetic diversity, areas likely to be inundated due to rise in sea level consequent upon global warming and such other areas as may be declared by the central government or the concerned authorities at the State/ Union Territory level from time to time.
2. Area between the Low Tide Line and the High Tide Line.

CATEGORY-II (CRZ-II)

The areas that have already been developed upto or close to the shore line. For this purpose, “developed area" is referred to as that area within the municipal limits or in other legally designated urban areas which is already substantially built up and which has been provided with drainage and approach roads and the other infrastructural facilities, such as water supply and sewerage mains.

CATEGORY-III (CRZ-III)

Areas that are relatively undisturbed and those do not belong to either Category-I or II. These will include coastal zone in the rural areas (developed and undeveloped) and also areas within Municipal limits or in other legally designated urban areas which are not substantially built up.

CATEGORY-IV (CRZ-IV)

Coastal stretches in the Andaman and Nicobar, Lakshadweep and small island, except those designated as CRZ-I, CRZ-II or CRZ-III.

13.8 NORMS FOR REGULATION OF ACTIVITIES

The development or construction activities in different categories of CRZ area shall be regulated by the concerned authorities at the State/ Union Territory level, in accordance with the following norms:

CRZ-I:

No new construction shall be permitted within 500 meters of the High Tide Line. No construction activity, except as listed under2 (xii), will be permitted between the Low Tide Line and High Tide Line.

CRZ-II:

1. Building shall be permitted neither on the seaward side of the existing road (or roads proposed in the approved Coastal Zone Management Plan of the area) nor on seaward side of existing authorized structures. Building permitted on the landward side of the existing and proposed road/ existing authorized structures shall be subject to the existing local town and Country Planning Regulations including the existing norms of FS/FR.
2. Reconstruction of the authorized buildings to be permitted subject to the existing FSVFAR norms and without change in the existing use.
3. The design and construction of buildings shall be consistent with the surrounding landscape and local architectural style.

CRZ-III:

1. The area up to 200metres from the HTL is to be earmarked as 'No Development Zone' No construction shall be permitted within this zone except for repairs of existing authorized structures not exceeding existing FSI, existing plinth area and existing density. however, The following uses may be permissible in this zone-agriculture, horticultural, garden pastures, parks, play fields, forestry and salt manufacture from sea water.
2. Development of vacant plots between 200 and 500 meters of high tide line in designated areas of CRZ-III with prior approval of ministry of Environment and Forests (MEF) permitted for construction of hotels/beach resorts for temporary occupation of tourists/ visitors subject to the conditions as stipulated in the guidelines at Annexures-II
3. Constructor/reconstruction of dwelling units between 200 and 500 meters of the HTL permitted so long it is within the ambit of traditional rights and customary uses such as existing fishing villages and gaothans. Building permission for such construction/ reconstruction will be subject to the conditions that the total number of dwelling unit shall not be more than twice the number of existing units, total covered area on all floors shall not exceed 33 percent of the plot size; the overall height of construction shall not be more than 2 floors (ground floor plus one floor).
4. Reconstruction/ alterations of an existing authorized building permitted subject to (i) to (iii) above.

CRZ-IV:

A. Andaman and nicobar island

1. No new construction of buildings shall be permitted within 200 meters from the High Tide Line shall not have more than 2 floors (ground floor and first floor), the total covered area on all floors shall not be more than 50 percent of the plot size and the total height of construction shall not exceed 9 meters.
2. The design and construction of buildings shall be consistent with the surrounding landscape and local architectural style. Corals and sand from the beaches and coastal waters shall not be used for construction and other purposes.

3. Dredging and underwater blasting in and around coral formation shall not be permitted.
4. However, in some of the islands, coastal stretches may also be classified into categories CRZ-I or II or III, with the prior approval of Ministry of Environment and Forests and in such designated stretches, the appropriate regulations given for respective Categories shall apply.

B. Lakshadweep and small island

5. For permitting construction of buildings the distance from the High Tide Line shall be decided depending on the size of the island. This shall be laid down for each island, in consultation with the experts and with approval of the Ministry of Environment and Forests, keeping in view the land use requirements for specific purposes vis-a-vis local conditions including hydrological aspects erosion and ecological sensitivity.
6. The buildings within 500 metres from the HTL shall not have more than 2 floors (ground floor and 1st floor), the total covered area on all floors shall not be more than 50 per cent of the plot size and the total height of construction shall not exceed 9 metres;
7. The design and construction of buildings shall be consistent with the surrounding landscape and local architectural style;
8. Corals and sand from the beaches and coastal waters shall not be used for construction and other purposes;
9. Dredging and underwater blasting in and around coral formations shall not be permitted; and
10. However, in some of the islands, coastal stretches may also be classified into categories CRZ-I or 11 or Ill, with the prior approval of Ministry of Environment & Forests and in such designated stretches, the appropriate regulations given for respective Categories shall apply.

10 TANK DESIGN

10.1 TYPES OF TANKS

a. Tank With Dioramic Background

It is usually noted that when tanks are decorated with corals, it becomes difficult to clean the corals regularly. Without regular cleaning the corals tend to grow algae on them giving them a dirty look. Hence avoid the corals. A dry diorama i.e. a lighted scene is created behind the wet tank. The sand filled in this portion is carefully blended to match that inside the actual wet tank. The light also is carefully selected to avoid the noticeable transition from wet tank to the dry tank diorama. Because light absorption of the water differs from that of air hence the transition is felt. If cool white lamp is used in water area and daylight lamps are used in dry areas, the transition effect is reduced. The following section shows the actual construction of the dioramic background.

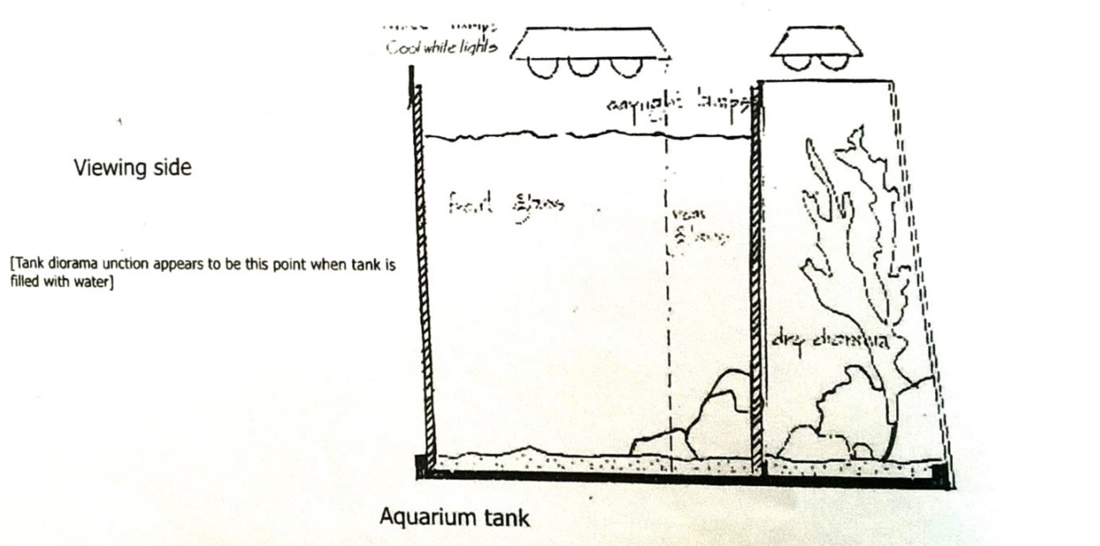


Figure 64 : Tank with Dioramic Background

b. Ocean shore tank

This tank replicates the ocean shore, complete with sand, waves and the shoe animal life. Wave machines are used here to produce waves so as to create a natural effect.

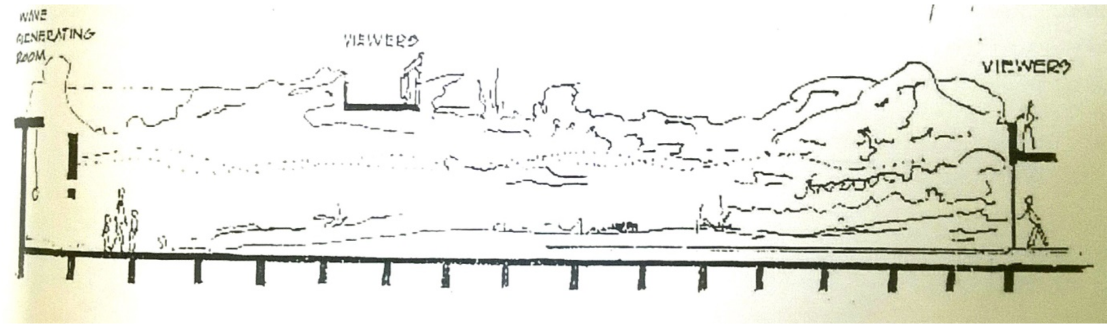


Figure 65 : Longitudinal Section through Ocean Shore Tank

c. Giant ocean tank

It is generally a free standing cylindrical tank, 50 feet in diameter and around four stories high with all windows all the way up and down. It has a depth of 25 feet of water. In this 20,000 gallons of salt water live sharks, sea turtles, stingray, moray eels and other marine animals are displayed. The giant ocean tank is a large basket of glass and concrete. Compression rings to support the outward pressure of 22 feet of water tie down its precast concrete columns together. The glass windows surrounding the sand are 54 inches wide and 74 inches high. At the bottom of the tank where the pressure on each panel approximates to 15 tonnes, the glass is 3 1/2 inches thick and is made of four laminations. Glass fibre piping is used for the piping purpose to meet the enormous pressure of water. The circulation of this tank contains 200,000 gallons of water. The sand is piled up into a slope, then the rocks are buried deep into the slope of the piled up sand, then the rocks hold the bank in its place and prevent it from collapsing. Rocks or the compositions of rocks are used as a focal point for the fishes to rest. However such elements should be avoided, as shy fishes prefer to go and hide behind them thus deterring their view.

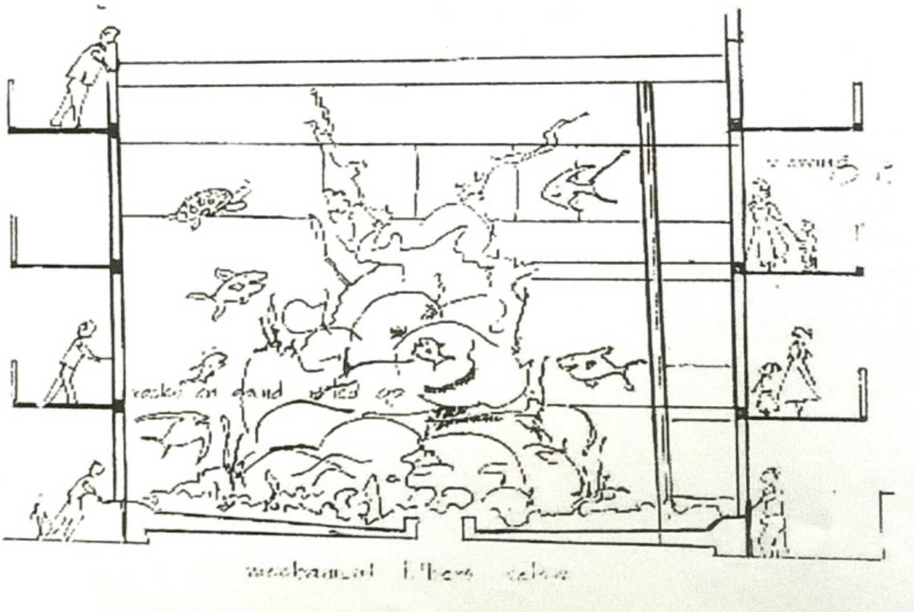


Figure 66 : giant ocean tank

Figure 67 : A glass railing at the top of the Giant Ocean Tank lets kids enjoy all the dynamic facets of the top

Figure 68 : New England Aquarium - 4 Story High Gian Ocean Tank

d. Shark channel and tunnel

The shark tunnel or channel should be torroidal in shape or circular ended to allow for the large turning radius of the sharks. The minimum width should be 24 ft. and a depth of 7 ft.

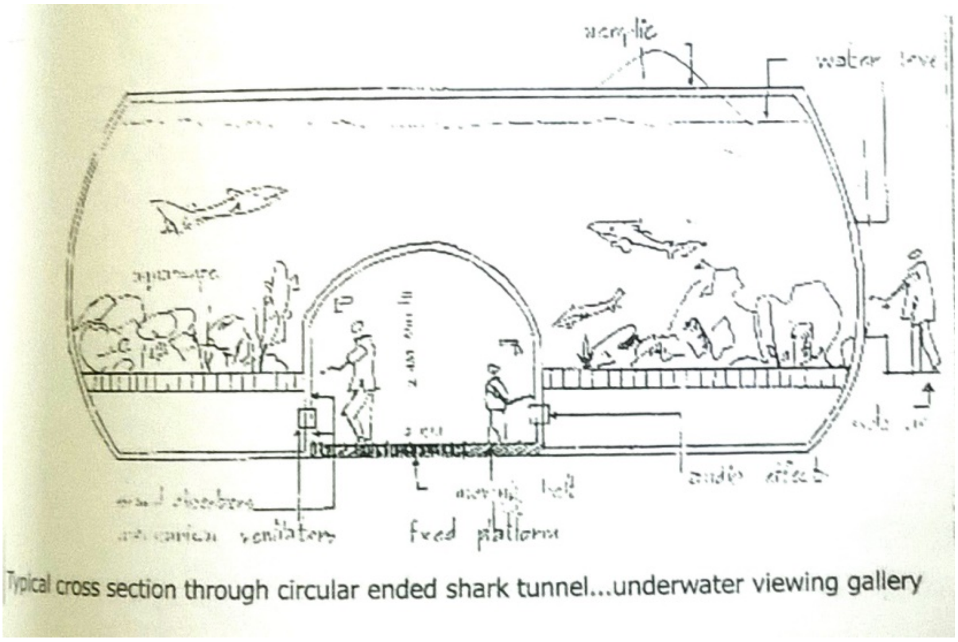


Figure 69 : cross section through circular ended shark tunnel

- Under water viewing gallery

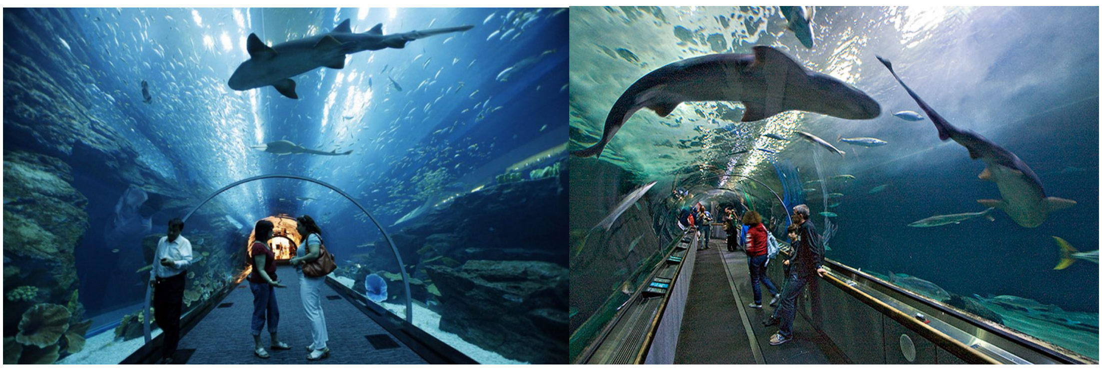


Figure 70 ; Shark Tunnel at Dubai Mall Aquarium

e. Coral reef tank

These tanks represent the tidal zone of the oceans. They can go higher to depict the mid and the bottom zone. Though the coral reef tank can he constructed fully in glass the technical and the constructional aspect need to be detailed out precisely. A full glass coral tank requires specific maintenance. To avoid this, R.C.C. tanks can be used such that it is punctured at different levels thus providing the view of the different strata of the coral reefs.

The coral tank is designed so as to give the visitors a feeling of being in water and observing closely the corals without the slightest fear of the above mentioned dangers. A tunnel could be created so as to enable the visitors to have a deeper look at the coral formations. Minimum depth required in the tank is 15ft. (4.5mts).

Figure 71 : Coral Reef Tank

10.2 TANK SHAPES

The aquarium display tanks can have different shapes according to the requirements:

a. Rectangular block tanks:

These types of tanks are suitable for small fishes or invertebrates living in shoals and measuring 0.3 to 0.8m. In length the size of the tank depends on the number of exhibits to be displayed in it. Usually for proper maintenance, tank capacity is restricted to 1500 to 2000 gallons (6750 to 9000 liters).

Advantages:

- Since the form of the tank is rigid it can be grouped to form a row; this type of layout is economical and saves on space.
- Tank with a height of 0.6m.needs to be arranged by the height of the visitors looking at the centre of the tank.
- Larger heights must have a proper viewing window distance maintained from the viewing tank.

Disadvantage:

Since the arrangement is in a single row it tends to be repetitive and monotonous and hence lead to museum fatigue.

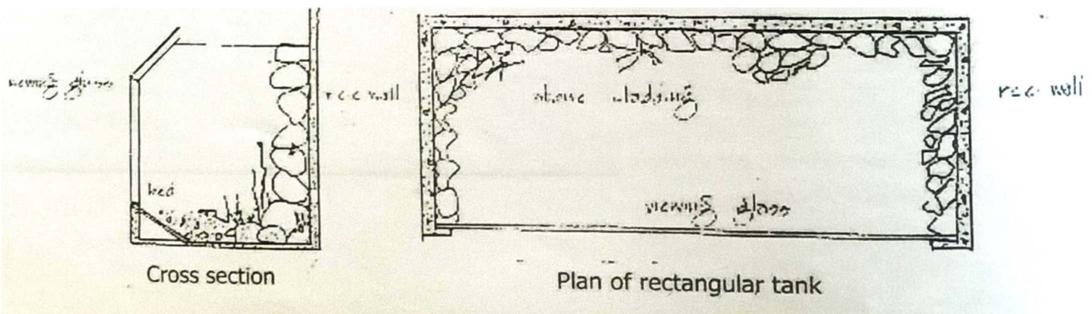


Figure 72 : rectangular block tank

b. Sloping sidewall tanks:

In these tanks the sidewalls are tilted to an angle, the maximum being 45 degrees so as to avoid the fishes from going out of the vision of the viewers.

Advantages:

- Due to the angle of the sidewalls feeling of spaciousness is created as the walls go out of the visual field of man. This sort of an arrangement facilitates better viewing.
- In all glass construction, side of the tank should be limited to the glass size, fabricated to the required specification. Fiberglass can be used in such cases.
- It is completely inert, light, readily altered, drilled and can resist water pressure to a certain limit larger size tanks are possible with the help of concrete for large size species.

Disadvantage:

The main disadvantage is that the spacing of these tanks needs some considerations if it is to be made economical. Also the total volume of the tank is restricted to 2000 gallons.

c. Rounded side tanks:

In this case the sides are rounded to prevent the aquarium from looking like concrete tanks with rigid forms. They help often to break the monotony. These are helpful especially for the sharks that are incapable of sharp or abrupt turns.

d. Oceanarium tanks:

Fishes, when swimming, tend to go in circles, especially fish of large size like the sharks and dolphins. Thus the tank can be circular, oval or doughnut shaped as shown earlier.

10.3 CROSS SECTIONS THROUGH TANKS

a. **Inclined surface:**

The surface of the water in the aquarium acts as a mirror. Giving an impression that the depth of the water is greater than what it is in reality. To get this effect the viewing glass/wall is built perpendicular to the line of vision of the spectators.

b. **Convex viewing surface:**

The convex glass enlarges the view of the exhibits inside the tanks and thus facilitates better viewing.

c. **Concave viewing surface:**

Concave glass diminishes the size of the exhibits, in the tank, giving the impression of a wider field of vision.

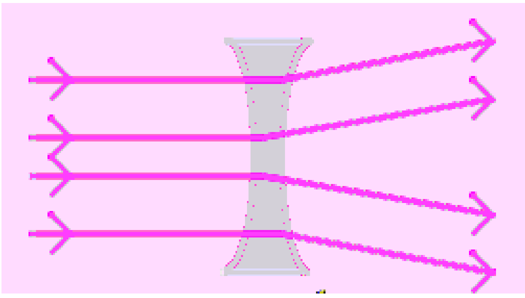


Figure 73 : Concave Lens

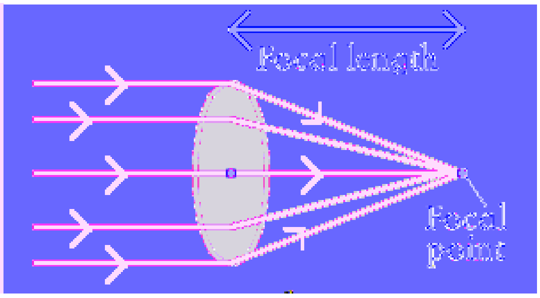


Figure 74 : Convex Lens

Figure 75 : Convex Viewing Surface

Figure 76 : Concave Viewing Surface

10.4 CONSTRUCTION MATERIAL FOR TANKS

Ideal tanks are those that are least costly, light in weight, readily altered or moved, inert in the seawater, with hard and smooth materials among other things. Though there are many materials available for lank construction, no currently available materials from which tanks may be produced have quite all the foregoing desirable features.

The different construction materials are as follows:

a. Fiberglass:

For small tanks containing about 2000 gallons of water fiberglass or plastic, impregnated plywood seems to be a good choice. Fiberglass is completely inert, light weight and can be readily altered or diluted fiberglass is probably the most practical supporting material for all but the largest tanks since it is lightweight, strong, does not deteriorate and can be easily fabricated into any shape. Adhesives for sealing the tank include epoxy resin, Polyvinyl chloride, silicone rubber and neoprene.

Figure 77 : Fibre Glass Tank

b. Glass:

Sheets of polished plate glass up to 6m in length can he used. As a thumb rule 1/4 inches or 6mm thickness of the glass for 12 inches or 30 cm of depth could be allowed. Therefore water that is 24 inches de per requires 1/4 inches thick glass and 36 inches deep requires 3/4 inches thick glass For an extra safely margin 1/2 inches should be increased.

Types of glass:

1. **Annealed glass**
2. **Laminated glass**
3. **Toughened glass**

c. Acrylic:

Acrylic is the very versatile, can be shaped into dome, and can be shaped into dome and cylindrical sections. Dome windows that project into the tank can provide an intimate fish eye view of the aquarium. Cylindrical tanks can provide attractive features, particularly effective when housing shoaling fish; tunnel forms also, provide a unique underwater experience. Acrylic can be separated but is a good insulator to cope with temperature differences that would otherwise promote considerations. Acrylic can be assembled with millions, sealant joints or with bonded joints. The latter can create an almost invisible joint, but due to lack of structural mullions would require the panels to be designed to a higher degree of safety. Panel sizes range from window panels 24ft long x 8ft high and 8 inches thick to tunnels 65ft long 5ft radius.

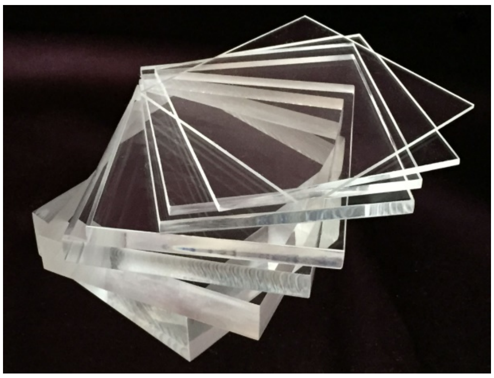


Figure 78 : Acrylic Glass

Figure 79 : Acrylic Oceanarium Tank

d. Rcc:

For longer tanks, RCC, steel plates or some other substantial suitable materials will be required. All concrete and metal surfaces should be coated with a suitable sealer these will continue to seal the inevitable hairline cracks in concrete and will thus prevent the seawater from attacking the reinforcing steel in the concrete.

Figure 80 : Construction of Coral Reef Tank

e. Sealants:

These are the essential parts of the concrete reinforced tank construction these are necessary to close the hairline cracks occurring on the sides of the tanks. Sealants also help in inhibiting algae growth on the sides of the tanks.

The different types of sealants available are:

Epoxy resins: It is claimed that this sets too hard and does not allow sufficient movement. These are extremely helpful in controlling the algae growth and in closing hairline crack.

Polysulphide: These can be attached by chlorine hence are not advisable.

Silicone rubber: These are soft elastic and well suited to the aquatic conditions. But their disadvantage is that they can be pierced out of the joints with sharp objects or by the inquisitive marine animals.

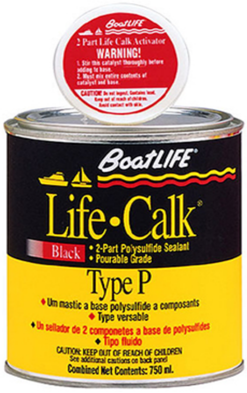


Figure 81 : Epoxy Resins

Figure 82 : Polysulphide Sealant

Figure 83 : Silicon Rubber

10.5 STRUCTURAL DETERIORATION IN TANK

The majority of materials are inert in marine conditions arc non-shrinking and do not stiffer from alkaline aggregate reactions which can lead to suffering of the latter.

The other component of the cement plaster binder can deteriorate due to the following causes:

1. Marine atmosphere contains salt, which increases the rate of corrosion of the marine structures.
2. The deterioration of structures in the sea has most notable effects, which include corrosion of metals, palling and degradation of concrete attack or limbo by marine organisms.
3. Frost damage cycles of freezing which lead to the disruption of the cement paste by the expansion of the absorbed water on freezing. However this effect is hardly effective in a climate like tuffs
4. Chemical attack: the sulphate ions present in the sea water reacts with the hydrate of the tri-calcium aluminates present in the canon_ The steel in the concrete is protected from corrosion by the highly alkaline atmosphere of the hydrated cement paste. This however may be broken by the chlorides present in the seawater leading to the rusting and the exfoliation, which if progressive may create a bursting pressure sufficient to cause spalling of the concrete cover.

The performance of the structures has been in the marine environment has been extensively surveyed and reported by several authors.

Accordingly, they suffer in general limited or no degradation. Severe corrosion occurs only in the 'splash zone' and in particular effects rectangular deck beams. Piles and cross bracing pieces. No similar corrosion occurs in the walls or the large circular piles except when the concrete cover is penetrated.

Such deterioration can be attributed to the poor design or poor construction carried out, such as vulnerable shape of the member, inadequate cover to the reinforcement, poor compaction, unsatisfactory design mix or the use of unsuitable materials.

It has been reported that no degradation has occurred in permanently immersed concrete even in structures which have severe corrosion in the splash zone it is seen from the tests, that the durability of concrete depends on the type of material used but also on the quality of concrete mix. Normally defined by the cement content and the water/cement ratio.

The degradation does not occur with the sulphate resisting cement that has the maximum permissible tri-calcium aluminates content of 4% thus several exposure tests have shown that increased durability of concrete with ordinary Portland cement, can be achieved by the use of clay or other materials as a part of replacement for the several types of slag arc available, but the most common is a ground blast furnace slag, which can be used to replace between 20%-60% of the cement. The concrete thus provided is essentially similar to that of Portland cement though much more durable. Many tests have shown that high alumina cement concrete have excellent strength. However their use is restricted due to high cost.

Steel Corrosion

The degradation of both steel and concrete is dependent on the zone of exposure, The most susceptible region is the splash zone, with the permanently submerged part of the structure being the least damaged.

10.6 STRUCTURAL CRITERION

ATMOSPHERE	ZONE
Decay and attack of timber, corrosion of steel and the spalling of concrete	Splash zone
Moderate to heavy corrosion of steel and spalling of concrete	Tidal zone
Heaviest attack on timber by the marine organisms. Failing of all materials	Sea water

There are basically three zones of exposure to corrosion:

Above high tide level:

This zone is concrete and mostly in-saturated state and is alternatively exposed to air.

Inter-tidal zone:

This zone is concrete, is mostly in saturated state, and is alternatively exposed to air.

Below low-tide level:

Oxygen available is limited but hydrostatic pressure can also cause rapid penetration of the sea water into the concrete. Although concrete structures have been found to be excellent a durable where deterioration of both concrete and steel is concerned.

Splash zone:

Corrosion of concrete and steel above and below water is fundamentally different with respect to the size of corrosion. Extra measure to deter corrosion in the splash zone must therefore be taken into consideration. Coat the concrete surface with bitumen and epoxy based materials. These must be absorbed into the pores, to be able to reduce penetration. Steel should be galvanized or should be cadmium coated.

10.7 CONSTRUCTION METHOD FOR POOLS ON ROOF TOP

The two basic methods of completely preventing water and vapour penetration below and on the sides of the pool shell and the adjacent areas are as follows:

Method 1:

To design and construct the pool in RCC with a sandwich type membrane incorporated in the floor and walls. There are several types of membrane, which can be used, but these fall into two main categories, sheet material such as chlorinated polyethylene, hyperon or heavy-duty polyurethane's. All membranes should be fully bonded to the base concrete.

Method 2:

To design and construct a pool shell as an independent structure located in a separate void provided in the building frame for the purpose. The pool is supported on the building frame and accessible-working space is left right around the outside of the walls and below the floor of the pool. The pool shell can be constructed with RCC; in situ post tensioned concrete, reinforced sprayed concrete or aluminium steel.

Figure 84 Roof Top Dolphin Tank

10.8 AQUASCAPE IN TANK

Aquascaping is the craft of arranging aquatic plants, as well as rocks, stones, cavework, or driftwood, in an aesthetically pleasing manner within an aquarium—in effect, gardening under water. Aquascape designs include a number of distinct styles, including the garden-like Dutch style and the Japanese-inspired nature style. Typically, an aquascape houses fish as well as plants, although it is possible to create an aquascape with plants only, or with rockwork or other hardscape and no plants.

Although the primary aim of aquascaping is to create an artful underwater landscape, the technical aspects of aquatic plant maintenance must also be taken into consideration. Many factors must be balanced in the closed system of an aquarium tank to ensure the success of an Aquascape. These factors include filtration, maintaining carbon dioxide at levels sufficient to support photosynthesis underwater, substrate and fertilization, lighting, and algae control.

A proper and balanced use of the following will ensure the correct ambience for the tank inmates:

Sand:

This should be fine enough for the fish to pick up their mouth, toss around, to forage in to, to rub against, to lay eggs in, but not so small as to mall down. Even though only 1 inch 2-inch layer provides a base for the plants to grow, but it is needed more to create banks and terraces. Colours of the tank Nor should be composed of non- toxic material.

Rocks/stories:

Hard stones, which are devoid of lime, should be used Other substitutes for rock are colored crystal lamps, which may be translucent or opaque. The advantage of using rock is that if the rock is buried deep into the disinfectant and the seawater is kept circulating, then the water running to the pool is sterilized.

Substrate:

The covering of the aquarium base forms two important functions. Primarily, it is used as a part of a biological filtrated system, it forms a large surface area upon which nitrifying bacteria's can thrive and carry out their purifying activities. Secondly it is used by the fishes that can bury themselves in the substrate at night, burrow into it by the day, or swim through it in the search of food.

Coral sand and courser crushed coral are the ideal materials for this purpose. Use the coarser material to form the lower layers of plastic or nylon netting. The netting will prevent the burrowing fishes from exposing the sub gravel filter plate. The substrate should be sufficiently deep to allow efficient bio-filtration to occur. A depth of at least 5 to 7.5 cms is recommended, and the substrate can be sloped from the front to the rear of the aquarium to an even greater depth. This not only makes it more interesting, but it also causes dirt and other remnants to collect at the front of the aquarium, where it is seen and removed.

Marine floor:

Various points of view must be considered while selecting different plant species to be planted. All chosen plants, possible, should represent the bio top and nature home of the marines. At the same, allowance for the plants survival should be kept as soft leaves and several fishes eat pinnate leaves of many plants. Large and fleshy leaves are victims to the claws of the lizards. Shrubs and bushes break down under the heavy weight of the reptiles and large frogs and turtles. In the landscape and in the crocodile hall. the plants can grow undisturbed by the animals. Here only aphids and other such insects can cause damage. While the extermination of such insects is impossible in an aquarium. a great success can be achieved with geckos-a type of lizard, as natural enemies set out against the destructive insects.

Growing plants in a marine tank is almost impossible, for it requires considerable expertise on the part of the aquarist.

Common tank plants:

Basically classified as-

1. Emergent plants

2. Floating leafed plants

3. Submerged plants

4. Algae

Figure 85 : Dutch Style Aquascaping

Figure 86 : Discuss In Nature Style Aquascaping

Figure 87 : Reef Aquascaping

10.9 CLEANING OF TANKS

The tank environment is very fragile: hence complete change of water as in swimming pools is not possible. The tank window is cleaned regularly by getting into the tank. Other surfaces are similarly cleaned and the unclean water is drained off with fresh water being simultaneously. Scuba divers would be required to clean large oceanarium tanks like the coral reef tanks.

Figure 88 : Scuba Diver Cleaning the Tank

11 SERVICES IN OCENARIUM

24.1 WATER SYSTEM

Types and methodology of working:

There are three basic types of water systems: open, closed and semi-closed.

1. Open Water Systems:

In open systems the water flows through the aquarium once and is discarded. This provides water quality comparable to that of the natural environment and there is no build-up of toxic metabolic wastes; however, temperature control and pumping are usually costly and filtration often is necessary. Hence an open system is not preferred.

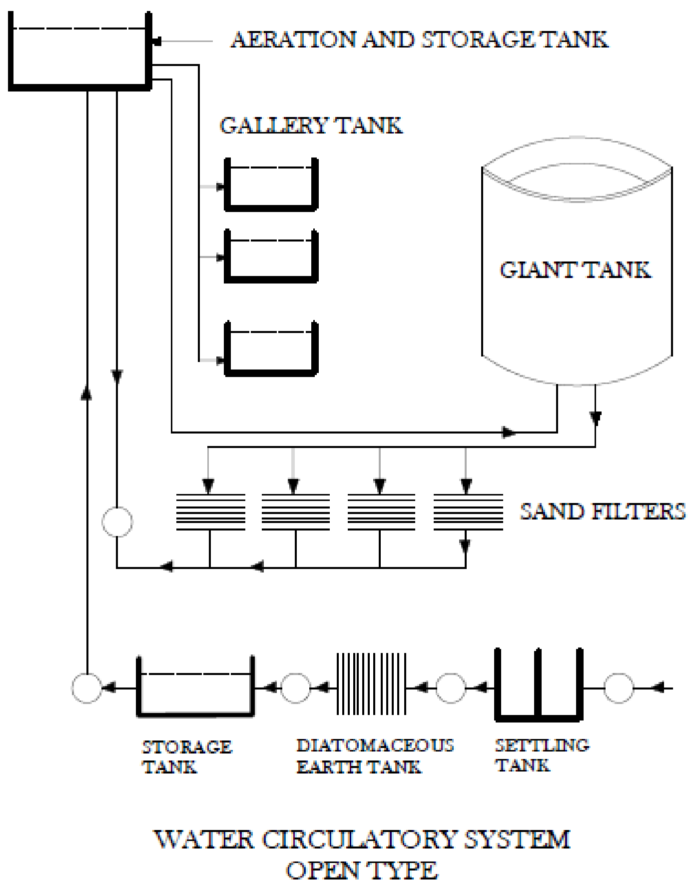


Figure 89 : Water Circulatory System - Open Type

2. Closed Water Systems:

Water is continuously re-circulated in closed systems and is only renewed periodically. Metabolic wastes must be treated since they are not continuously flushed from the system. An important problem is that ammonia must be rapidly removed or transformed because it is harmful even at very low concentrations. In the aquarium the bacteria that converts ammonia to nitrite reside primarily in the filter material and a slow sand filter with a large surface area is usually provided to ensure their abundance. Plant growth in the aquarium, especially in marine systems are not usually sufficient to utilize the entire nitrate produced by bacteria from nitrite. Although some aquariums have operated many years with a minimum of water renewal, it is normally necessary to replace from 1 to 10 % of the water per month to maintain a low level of nitrates. The use of charcoal in both fresh water and seawater system helps to slow down the accumulation of nitrogenous wastes. Metabolic wastes also cause an increase in the acidity of water. Carbonate compounds are commonly used to maintain an optimal level of acidity, particularly when water renewal is infrequent.

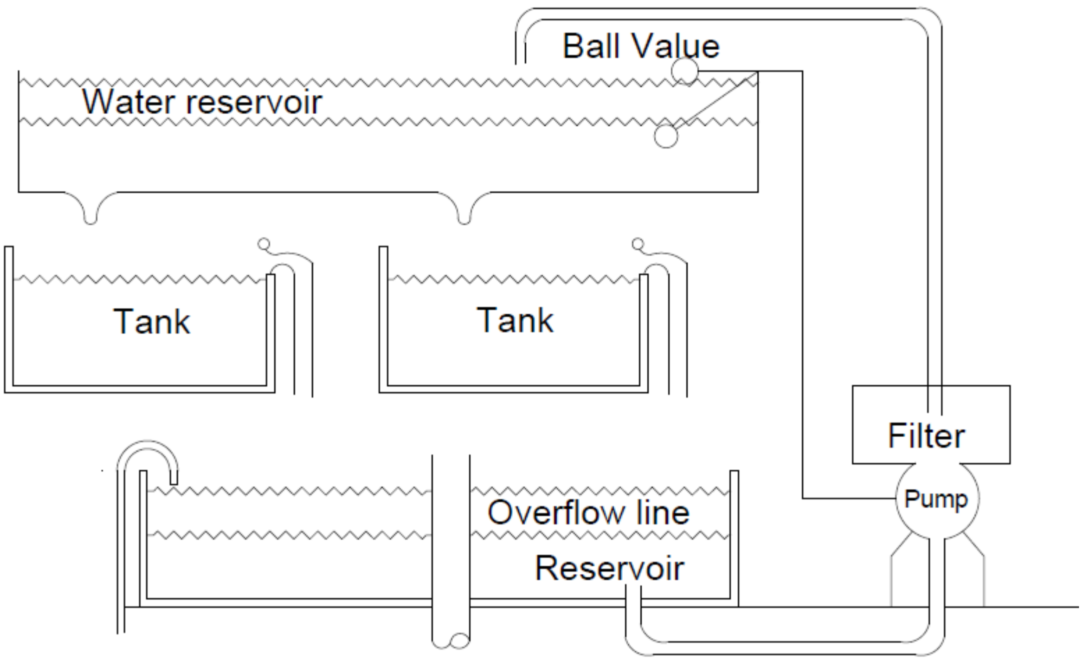


Figure 90 : Closed System with Ball Valve

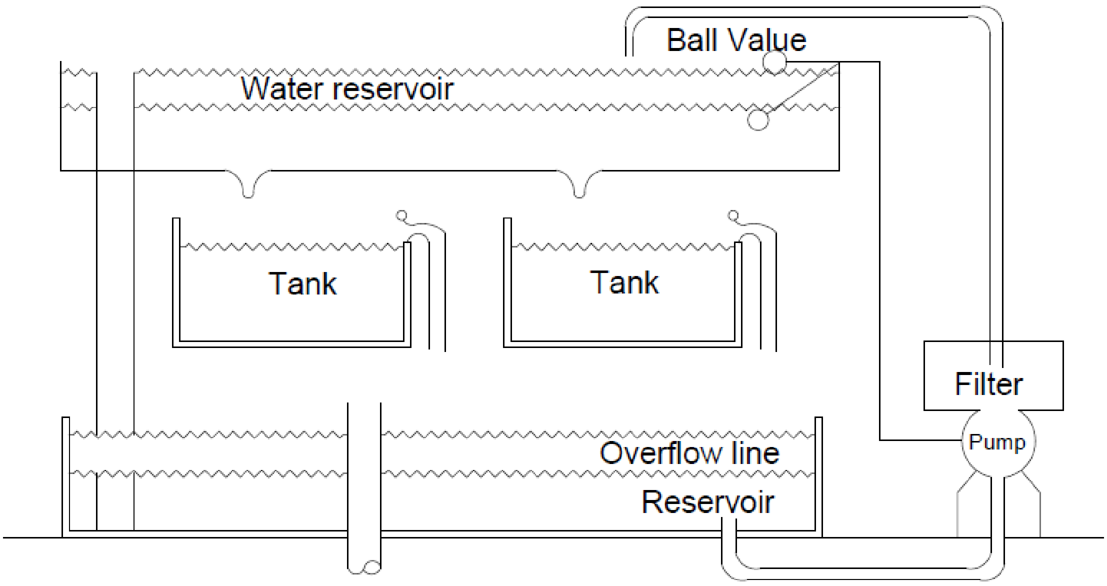


Figure 91 : Self Improving Closed System

Advantages of Closed Water Systems:

- Unless aquariums can be built near a dependable source of water, which is unpolluted, disease free and clear closed water systems become necessary.
- Completely closed system in which water is added only to make for the loss by evaporation.
- The closed system which has some flows through.
- The site selection need not be dictated by unavailable fresh water source.
- Environmental control of various parameters such as salinity, temperature and photoperiod.
- Ease of monitoring as storage is in reservoirs.
- Convenience of sampling.
- Convenience of continuous visual monitoring.
- Ease of maintaining several systems simultaneously.
- Preferential selection of the biota without the danger of contamination of the water by the plank tonic forms.
- Natural water is subjected to seasonal temperature fluctuations and may be subjected to natural effects as storm, floods etc. it may be carry various parasites, pollutants are also taken care of in a closed water systems.

By equipping a closed water system with good aeration and an efficient biological filter the two most serious problems-ammonia toxicity and the change of the ph levels can be greatly reduced.

3. Semi-Closed Water Systems:

Semis closed are the same as closed systems except that there is a constant connection to the water supply and the problem of dissolved wastes is controlled by the regular addition of new water; this system is more economical than the open type in terms of temperature control and pumping.

Systems vary through simple flow through systems to completely automated re-circulating systems with special provisions for monitoring and controlling the physical and chemical characteristics of water.

The turnover rate or rate of water replacement, of individual aquariums is important and should be no more than two hours. In addition, aeration by means of air stones (diffusers) should be provided to guard against asphyxia in the event of an unexpected water supply failure.

Fishes and invertebrates can also be maintained without filtration or aeration in aquariums that are 'balanced' with plants; however, the balance between plants and animals is very difficult to attain on a large scale or even in a normally stocked aquarium, especially a seawater aquarium.

Freshwater pools for mammals and birds present a special problem. They generally require a higher filtration rate and greater filter capacity because they accumulate large amounts of faecal wastes. Air-breathing animals, however, are not highly sensitive to water quality; thus, chemical treatments, such as chlorination, which could kill fishes, can be used to control bacteria and to improve water quality. Seawater formulas are simpler; for e.g. a 2% sodium chloride solution will satisfactorily maintain whales and dolphins. Seals and sea lions have been kept in fresh water, but this may increase their eye problems because of the osmotic effect of the freshwater on the eye tissues.

The following parameters have to be agreed to:

- 500 litters of cultured water are needed by per kg of animals.
- Bed consisting of 2.5 mm grains of calcareous filter containing some magnesium shall be used.
- A flow rate of 80 litters per minute through each sq, m of the filter bed surface shall be maintained. Replacement of 25% of cultured water per month or in some cases 33% every fortnight. The lamp and the water surface will prevent damage and will cut down excessive losses due to evaporation.

24.2 FILTRATION SYTEM

The Need:

Aquariums are confined to a limit quantity of water, as compared to the natural habits than in the wilds. In the wilds the first waste are instantly diluted. While in the aquariums the nitrogenous wastes keeps on building up thus increasing the toxic levels. The waste contains ammonia gases, which are very harmful to the fishes. More the number of fishes more the wastes and hence more the risk of increase3 in the ammonia levels. To remove this ammonia formed in the tanks various filtration methods are used. The bacteria feed on the nitrogenous wastes, decompose it and break down the ammonia into smaller particles called nitrates, which are less toxic rather than being non-toxic. Fishes can tolerate a certain level of nitrate but over a certain period of time these nitrates build up and become harmful, hence they need to be removed from time to time. Since nitrate is a fertilizer excess of nitrate would lead to the growth of algae.

Water Changes:

Though there are many ways of filtering water, in case of tanks the best way to remove nitrates is to change the water periodically. The amount of water to be changed every day would depend upon the nitrate level in the tanks. Thus a regular check of the nitrate level is done to decide the water change schedule.

Biological Filtration:

It is a term for fostering ammonia-neutralizing bacterial growth. Bacteria decompose ammonia to nitrates which are less toxic this bio filtration is not quite adequate for large number of fishes hence biological filters have been devised which vastly increase the bacteria colony in the aquarium. These filters provide additional surface area for the bacteria to attach themselves and increase the oxygen content of the aquarium.

Mechanical Filtration:

It is the straining of the solid particles from the aquarium water. It does not remove directly the dissolved ammonia nor does it remove the algae or the solid particles trapped in the plants and other objects. Wave makers improve the chances of removing the trapped solids through the mechanical filter or vacuum filters can also be used. Mechanical filters use filter material such as sponge paper phlox etc. sponge being the commonest. These filter media have numerous small pores, which trap the particles. These get clogged after some time and need to be cleaned.

Chemical Filtration:

This is the removal of dissolved wastes in the aquarium waters. The dissolved wastes are of two types, polar and non-polar. Chemical filtration in case of non-polar can be actively achieved by filtering the water through gas activated carbon. This works best on non-polar wastes though it also removes polar wastes. Polar wastes can also be removed by another method called protein skimming, which is very effective in removing dissolved, organic. Gas is developed from carbon, which is processed to develop large number of minute holes, which trap non-polar wastes at molecular level by means of ion exchange and absorption, and carries out a process of molecular sieving. Reef aquaria people are concerned about the phosphate leaching from activated carbon. Low ash carbons have low phosphate leaching chances and they also reduce the chance of undesirable pH shifts.

Zeolite:

This is another chemical filtrate. Protein skimmers are used in reef aquariums. They have an ability to remove organic matter before it decomposes. The process involves taking advantage of the polar nature of the molecules, which are attracted, to the surface of air bubbles injected by column of water. The resultant form is gathered and skimmed off.

Integrated Total Filtration:

Modern advancement in filtration technology has produced total integrated systems, which are aimed particularly at the marine end of the fish keeping market. They include some form of mechanical filtration followed by a biological filtration, including a denitrifying filter. For marine tanks, such a set-up also has protein skimming. In an integrated system, filter parts are modular and easily serviceable, but the combined bulk of the systems on top of the tank often make special hood and lighting necessary.

24.3 DIFRENT TYPES OF FILTERS

» Corner Boxes:

These are internal filters generally made as plastic boxes placed on the corners. These are driven by an air stone, using the principle that when the air bubbles rise in water they pull the water with them. The water is passed through one or more media in a box or cylinder in the tank. This system is fairly inefficient with a poor flow and is now less widely used.

» Under Gravel Filters:

Under gravel filters work by passing the water through the gravel layer, this sits on top of a perforated plate. Water can be pumped by airlift with the bubbles lifting water through a water column in a vertical tube attached to the plate. Power heads are attached to increase the flow of water. UGF's are good biological filters since the slow flow of water fosters large colonies of bacteria in the filter, which neutralize the ammonia. But they are bad mechanical filters because the fish wastes get pulled away inside the gravel and it gets clogged. A reverse flow under gravel filter is available to solve this problem.

» Sponge Filters:

These provide an efficient and economical form of biological filtration. Water is drawn through the porous foam by means of power heads or by bubbling air by air tubes. The flow of water through the foam fosters the growth of bacteria in the foam and biological filtration takes place.

» Power Filters:

These consist of a siphon tube, which pulls water from the tank into a filter box and passes it through a mechanical filter. The sponge acts as a flexible filter media for biological filtration to take place. An internal filter then returns the filtered water to the aquarium. These power filters are much easier to maintain like the power filters are available in a variety of sizes & design as suited to the requirements of the tanks.

Power filters are also available with a number of fancy features. Many are supplied with chemical filtration media such as granular activated carbon.

- Canister Filters:

These are designed for powerful mechanical filtration. The water is pumped, at moderate pressure, through a filter medium such as glass wool or mixed filter cartridge. They are useful in aquaria having large messy eaters. They can be hung on the tank. When they sit on the bottom of the tank they are known as submersible filters.

- Trickle Filters:

These work on the principle that the beneficial colonies of ammonia nitrifying bacteria grow best in the presence of well oxygenated water. By trickling over unsubmerged objects, the wet/dry filter provides a large surface area. They are available in many shapes and sizes. The boom in successful saltwater aquariums can be attributed to the use of this kind of filters.

- Protein Skimmers:

Protein skimmers were initially developed for use in industrial sewage treatment plant where they are also known by the term foam fractionator. Protein skimmers have the unique ability to remove dissolved organic wastes before they are decomposed. This is accomplished by the fact that organic waste is attracted to the surface of bubbles, which are pushed large numbers through a water column. The foam is then skimmed off the water, and at the same time removing the organic wastes. The foaming process only takes place in water. Of high pH and salinity and hence this system is only used in marine water aquariums.

- Denitrators:

These work on the principle of biological filtration. These fall into categories, the anaerobic bacterial and plants' algal scrubbers. It works on a principle discovered that colonies of bacteria which grow in oxygen poor environments can be harnessed to biologically convert ammonia and release harmless nitrogen gas. This was done by two methods. But repeated failures were heard about this type. These aquariums involve the use of large amount of harvested from tropical reefs, which are reputed to have good nitrogen content in the live rocks.

- **Algae Scrubbers:**

Algae scrubbers make use of live algae to do the filtration. The water is run over a wire mesh in a trough under bright lights, where algae are encouraged to grow. The growth of algae removes some pollutants from the water. This is a controversial form of filtration for the reefs and large marine ecosystems. Some are of the opinion that if the complete filtration solution others are of the opinion that it leads to poor water quality and algal growth in the tank as well.

One interesting characteristic and underlined principle behind this growth of turf algae is the necessity for grazing by members of the animal population. The algae must be cut back or grazed, much like the grasses in the backyard or the other spaces, which are not as efficient at removing nutrients from the system, will develop. The use of 1000 micro window screen allows easy scrapping of the algal filaments and provides a protective matrix in which the basal portions of the algae can grow. The screen is removed from the tray, scraped with a piece of straight-edged perspects rinsed and placed back into the tray. The algae that has been removed, along with the absorbed nutrients is dried in an oven and weighed. This is done to help determine how efficient the scrubber is during various times of the year. The algal turf scrubber is a way of increasing surface area for algal growth and the greater efficiency and removing nutrients.

Algae are the key to keeping the water clean. They remove waste from the water and put oxygen back in at the aquarium they are found outside the tank. The farm grows special algae in 72 separate shallow trays (scrubbers) on the roof of the building. In each scrubber algae grow on 2 in. -square plastic mesh screens over which the aquarium water is passed in a surging motion to increase the growth rate. The algae grow quickly, forming a lawn, which requires a mowing every 5 to 14 days. Mowing involves scraping the algae from the screens with a piece of straight-egged perspires. Productivity of the scrubbers can be increased by the use of powerful 1000-watt lights at night to extend the effective day length for photosynthesis.

• Sterilization:

In especially sensitive aquaria the infections resulting from water borne parasites, fungi, bacterium, and virus can cause serious problems. Water sterilization is most important for breeders, for centralized multi-tank filtration, for delicate and closely spaced setups such as large tanks and reef systems. Healthy aquaria depend upon beneficial bacteria growing on the filter media, which neutralizes ammonia. Total sterilization is not desirable.

Two main types of sterilization are used ozone injection and ultraviolet irradiation.

• By ozone:

Ozone is highly reactive and is a powerful oxidizer of organic pollutants, including live pathogens. It also systematically reduces dissolved organic compounds in the water stream, which increases the reserve capacity of the water to oxidize organic waste through the aquarium. Ozone laden water also improves the ability of protein skimmers to generate foam, which increases their overall performances. But ozone gas is highly corrosive and is very unsafe for breathing hence is not recommended.

• Ultraviolet sterilization:

High intensity ultraviolet light destroys the DNA in the living cells and can be used as an effective means to control living pathogens. The most effective light is the high energy UV light roughly around the wavelength of 250 angstroms. To be effective the UV light should expose the pathogens to a high enough light intensity for a long enough period.

24.4 PIPING IN AN OCEANARIUM

All the piping should be of non-corrosive and chemically inert materials. Non-wettable pipes with smooth interiors should be used so that the chances of the marine organisms getting a hold and forming colonies are reduced. Piping should be preferably non-metallic as even lead and steel, which are generally considered safe, are affected by seawater. Where unavoidable metal pipes are used as to se cetaceans, seals, penguins but this may prove clear in the long runners expensive replacements are generally required due to corrosion. The use of copper for piping should be absolutely prohibited.

The materials most commonly used for the pipes are

- Rigid PVC
- Vulcanite
- Ebonite
- Fiberglass
- Cement line steel pipes
- Cement lined galvanized iron pipes for fresh water
- Thoroughly cured cement concrete pipes

The water is first pumped to a height and then fed to the tanks by gravity. Thus the water in the pipes is under pressure and they should be designed with adequate strength to resist it. The piping should be placed under the service passage and neatly stored in drainage gullies with a narrow feed pipe to each tank. Feed pipe should come up in through the tank bottom so that the water enters the bottom and overflows to the tank. The ideal solution is to line up the feed at the top eliminating any layer of dead water at the bottom ensuring proper circulation and consistently ample oxygenation and an encouraging specimen to occupy the whole of the tank. The ideal solution is the line up of the feed oxygenation and an encouraging specimen to occupy the whole of the tank. The ideal solution is to line up the fresh water pipe with the drainpipe. Thus, by opening the feed valves, the correct water amount can be introduced by closing these and opening both, the tank can be rinsed, only or all of these operations can be done at the same time.

INLETS

The covers over the openings of feed pipes inside the tanks have to be finely perforated to let water through but preventing the specimen from entering the pipe. Sharp turns are acceptable with metal pipes. Short turns should also be avoided with large diameters as required.

All the electric installations, plumbing or airlines should be embedded in the concrete. External piping should not be embedded in loose soil.

RESERVE WATER

The reserve water is used mostly for routine replacement. Its quantity may equal the gallonage of the largest single display tank, if it considerably exceeds that of the others. In such cases the water could be adequate for more contingencies except catastrophic disaster. Reserve water is used to compensate cleaning losses; evaporation losses and to provide fresh water in order to avoid build-up of harmful bacteria.

24.5 LIGHTING IN AN OCEANARIUM

Lighting constitutes a highly important and a highly sophisticated part of an aquarium. For keeping the aquarium healthy, well balanced and flourishing, it is essential for the aquarist to take proper notice of the lighting in the aquarium. A perfect aquarium should have electrical lighting supplementing the natural lighting. In an aquarium it is necessary to provide the proper lighting. Some lights can stimulate groups of brown algae as natural light does, but in a fresh water system plants thrive best in little sunlight than in electrical light plants are very demanding in their light preference hence it is necessary to provide the correct type and intensity of lighting required. The entire inhabitant fishes as well as plants have specific requirements of light. Although they may survive in not so ideal conditions they may not necessarily flourish.

TYPES OF LIGHTING

Lighting manufacturers have responded to the different needs of the aquarists by providing a range of bulb type and qualities. In general the human eye responds to the aquaria lit with yellow green light because it appears warmer and more appealing. Plants however prefer red/blue ends of the spectrum. Although some light is absorbed in the water, the average aquarium is not deep enough or normally not cloudy enough, for these to make an appreciable difference.

1. NATURAL LIGHTING

This is a correct spectrum range for all animals and plants. This encourages algal growth. But this is quite unpredictable and uncontrollable. Excess of sunlight would cause excessive growth of algae, which would suffocate the aquarium.

2. TUNGSTEN LIGHTING

These are extremely unsuitable as a form of illumination for any type of modem aquarium. They do not give an optimum light spectrum for good plant growth and are efficient, converting most of the energy into heat, rather than into useful light output. They are therefore no longer recommended as they have nothing to offer to the aquarist.

3. FLUORESCENT LIGHTING

Fluorescent tubes are the most suitable form of aquarium lighting. They give a better spread of light and are relatively cheap to run in cool operation.

4. ENHANCED RED/BLUE

Output contains the correct spectrum for the plant requirements and is thus good for plant growth. Light output is low, however therefore this type of lighting is generally used in conjunction with full spectrum bulb.

5. FULL SPECTRUM

This stimulates daylight and is extremely useful where space permits only one bulb. 67. 6. Spot lighting: These are ideal for creating dramatic and for emphasizing any surface water movement. They are particularly useful for punching light down to the relatively deep tanks. Focusing the spotlight on a particular tank will benefit the sea anemones, for example who will migrate to that area to look into the brighter spot.

7. MERCURY VAPOUR LAMPS

The point source light produced is bluish white, which gives a sea bed effect will sow fishes off in their best colors in the aquarium. These are suitable for large public aquariums, where their light output can be color corrected with a supplementary lighting in a different spectral balance.

8. HIGH PRESSURE MERCURY VAPOUR

High power lighting for tanks deeper than 45 cms. It is less costly than metal halide; it has a fairly broad spectrum, but is lacking in blue/green wavelengths and requires blue supplementary lighting.

9. METAL HALIDE LAMPS

Although its lamp has a tungsten filament, it produces a more intense light that an ordinary tungsten lamp. Any tungsten evaporated from the filament at an extremely high operating temperature combines with the halogen vapour within the quartz envelope of the lamp and is re-deposited back on to the filament, extending its effect on us. Mounted 30 cms above the tank, in a suitably designed reflector, a 150-watt lamp will illuminate the area of approximately 1800 cms. This light is more pleasing than pressure mercury vapor because it has improved red/yellow output. Produces an intense light suitable for marine tanks, especially the deep ones. This is the most expensive form of lighting and is usually requires a large housing.

INSTALLATION:

DURATION AND INTENSITY OF LIGHTING:

The lighting should be kept on for at least 12 to 15 hours a day, but the intensity can be reduced from its full intensity to a low level for evening viewing, in as semi natural aquarium the aim is to have a reasonable light for algal growth that does not take up the entire aquarium space. As a whole one should allow 5 watts of power per 100 cms of water surface area. In a 300 mm tank it works to around 135 watts. Four thirty-watt tubes should suffice for this.

TEMPERATURE:

For economic reasons it is desirable to maintain an even temperature of 72 degrees f. is comfortable for the visitors and will maintain display tanks temperature also at the same level. A great many fishes and organisms are comfortable at this temperature. Heat exchange equipment can be provided for the individual tanks when warmer or colder water is desired.

CARE AND USES OF LIGHT:

Whatever lamps one uses they must be protected against water damage either from direct spray and splashes, or from condensation. Water proof lamp fittings safeguard the electrics and a glass cove; fixed on the top of the aquarium between the lamp and the water service will prevent the damage and cut down the expensive evaporation losses.

GUIDELINES FOR GOOD LIGHT:

The goal of architectural lighting is to create the visual environment that the best accommodates the function intended. Visual comfort results when we are able to receive clear visual information that we intentionally or consciously want to receive. Some general guidelines for getting good lighting are given below:

Visual conditions should be made comfortable and should conform to the acceptable quality of light. Also the light sources must not be a source of discomfort glare.

Visual conditions are improved if the visual conditions are distinguished from its surrounding by being brighter, more contrasting, more colourful, strongly patterned or a combination of two or more of these factors.

Sufficient overall light should be provided in rooms with focal light on the visual task. Avoid creating conditions where the eye will have to adopt too quickly over too great a range of brightness.

Dull uniformity should be avoided. For example small point of light from low wattage light source can contribute 'sparkle' without glare. Sparkle or glitter occurs when a pleasant combination of luminous brilliance is achieved.

Flat surfaces should be evenly lit unless focus is to be laid on art, Panels etc. Enough light must reach the ceiling in order to avoid gloomy conditions, which occur when desired visual condition on structures is missing. Light sources should be selected with regard to color rendering needs of people, finishes and paintings.

Surrounds should be moderately bright. Reflecting from the wall and ceiling surfaces should provide for the light. Daylight should be provided through openings to achieve contact with nature and people and to induce feelings of well-being and freshness. Variety of light is the dominant daily characteristics of natural light.

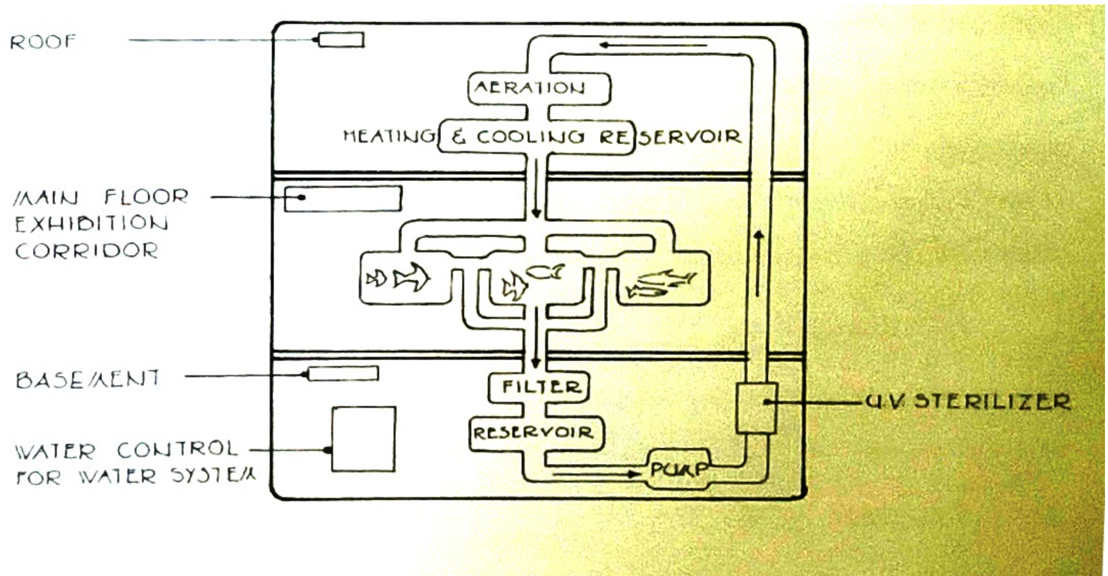
RECOMMENDED ILLUMINATION

Illumination category	**Ranges of luminance maintained in services in lux (fc)**	**Types of activity**
General luminance through the room		
A	20-30-5 (2-3-5)	Public spaces with dark surroundings. Simple orientation for temporary visits. Working spaces where visual tasks are only occasionally performed.
B	50-75-200 (5-7, 5-10)	
C	100-150-200	
Luminance on task:		
D	200-300-500 (20-30-50)	Performance of visual tasks of high contrast or large size, reading print material, typed originals, good xerography, rough bench and machine work, ordinary inspection rough assembly.
E	500-750-1000	Performance of visual tasks of medium contrast or small size, medical bench and

		machine work difficult inspection, medium assembly.
F	100-1500-2000	Performance of visual tasks of low contrast or very small size, high difficult inspection.

24.6 FLOORING IN SERVICE AREA

A non-skid surface can be achieved by the application of a chlorinated rubber permit or an epoxy resin or polyurethane followed by a sprinkle of fine sand before the paint or the resin has hardened. For economic reasons it is desirable to maintain an even temperature throughout an aquarium structure. A temperature of 72 deg. F (22 deg c.) comfortable for the visitors and will maintain display tank key also at the same level.



SIMPLIFIED DIAGRAM OF WATER SYSTEM

14 CASE STUDIES

24.7 IMPORTANCE OF CASE STUDY

One of the most significant and logical ways to begin an understanding process of the an oceanarium environment is to observe facilities which are already in existence. From such observations, a designer seeks to understand the design goals that were set forth in the previous situations. Once those goals are better understood a determination of the successes and failures within those projects can be ascertained. The successes and failures can then be studied to determine their appropriate application or deletion from the project being undertaken.

For the purpose of this project,

24.8 LIVE CASE STUDY

1. TARAPOREWALA AQUARIUM

Project: Taraporewala Aquarium Project

Address: Chianti Road, Marine lines, Mumbai, India.

Client: Shri & Shrimati Vicaji D.B. Taraporewala

Date of Commencement: 9th May 1947

Date of Completion: 27s' May 1951

Actual Cost: Rs. 8,90,904/-

No of species: 400

Volume of largest tank: 22,000

Annual visitors: 400000

Figure 92 : Location Map of Taraporewala Aquarium

Figure 93 : Outside view Of Taraporewala Aquarium

CREDIT

The Aquarium owes its existence to the munificence of Mr. Vicaji D.B.Taraporewala, whose donation of Rs. 2 Lakhs enabled the fulfilment of a dream Mat was hanging since 1912. Now it is supported by government of Maharashtra.

LOCATION

The aquarium is located on one of Mumbai's prestigious locale—The Marine Drive. It faces the sea on the other side of the Marine Drive Road.

SITE AND ENVIRONMENT

The site was selected to construct the aquarium at the Queen's Necklace—Marine Drive could not have been more appropriate, as the Mumbai of yesterday was a fishing village and the site has a sea-face. The Govt. of erstwhile Mumbai State provided land to construct educational and recreational centres.

a. **Site Surrounding:** Opposite to the site is the marine drive. There are some hospital and school buildings around the aquarium.
b. **Topography:** The Aquarium is built on flat terrain without any contours.
c. **Link of site with surrounding:** Site is connected with the six lane concrete road .
d. **Structure in General:**
    - Building type -low-rise building.
    - Foundation System –pile foundation
    - Façade Material –Concrete.

DISPLAY

There are 100 species of marine and freshwater fish including seven types of coral fish from the Lakshadweep Island. Attraction includes turtles, rays, moray eels, sea turtles, small starfish and stingrays. Exhibits offer a glimpse of the variety of marine life in the Arabian sea and Indian ocean.

- **Damselfishes:** territorial fish species including golden damselfish, moon tail, cocoa, striped, electric blue, talbot, and sergeant major damsel
- **Butterfly fishes:** chevron, copper band, long-nose, eight band, red perl
- **Angelfishes :** blue ring, regal, wraft and emperor angel fishes
- **Triggerfishes :** undulated, bluetooth, picasso and clown triggers
- **Marine eels:** yellow head, white ribbon, black ribbon, blue ribbon and moray eel
- Marine touch pool with sea cucumber, sea urchin, brittle star, tube worms, star fish and more
- **Groupers:** sweetlip, panther, orange spot and black spot groupers
- **Tangs:** yellow, powder brown, naso, orange shoulder, and powder blue
- **Unique species:** oranda, stone, red cap, rukin, and black moor
- Other species including bat fish, squirrel fish, golden travery, puffers, jelly fishes, kombada, lion and turkey fish, dwarf lion, whimple, moorish idol, marine coral reef, wrasse, sea anemone, negro, clarkii, and arowana
- Paludarium aquarium with Indian carps: rohu, catla, mrigal
- Tropical aquarium fishes, red tail, sucker, upside down and Asiatic cat fishes
- Other species include: octopuses, seahorses, alligators, catfishes, gold fish, sea turtles etc…

Figure 94 : Sea Turtle

Figure 95 : Flower Horn

Figure 96 : Blue Diamond Discuss

CIRCULATION

- The 3 storied building has an aquarium and related offices on ground floor.
- First floor has an administration and research department. Second floor is occupied entirely by the library.
- Public circulation path for the aquarium is in inverted U- form with entry on the right side and exit on the left side.
- Service passage lines peripherally around the display tanks and remains visually and functionally independent.

STRUCTURE AND MATERIALS

R.C.C. beam and column construction, galvanized pipes for pipelines, glass for aquarium tanks.

FOUNDATIONS

The foundations of the aquarium rests on reinforced concrete piles, mainly of which have been driven to 30ft. deep so that the building may be claimed to be earthquake proof The building is three storied and 200(61ft) away from the sea wall. It is rectangular in form with it long axis running from west to east.

The Aquarium is maintained by Department of Fisheries itself.

DISPLAY:

TANK:

- The tanks are of R.C.C shielded by a 32mm thick clear glass. The walls at the back are maintained rough with P.C.C coarse layers.
- These layers actually facilitate fixing of bacteria apart from projecting natural scenery.

LIGHTING:

The display are lit by overhead florescent tubes as incandescent types generate heat and cause discomfort to species. The visitor area is unlit for creating the ambiance.

DETAILS OF EXPENDITURE FOR MAINTENANCE OF AQUARIUM AS IN 1994 ARE:

• Building	Rs .5, 77,974.00
• Water and aeration	Rs.1,07,150.00
• Electric installation	Rs. 74,079.00
• Gas Connection	Rs. 3,700.00
• Water barge	Rs. 80,000.00
• Miniature exhibits	Rs. 6,000.00
• Fridge, aquarium tanks, scientific equipment	Rs. 42,000.00
• TOTAL	Rs. 8,90,904.00

Figure 97 : Long Queue outside Taraporewala Aquarium

Figure 98 : Exhibition Tanks in Taraporewala Aquarium

NEW ATTRACTIONS:

- Oceanarium in the foyer with 22,000 l (5,800 US gal) water.
- Amphitheatre with 50 seats, screening documentaries on fish, marine ecosystems and environment conservation.
- Touch pool, where curious visitors can touch star fish, sea urchins, sea cucumbers, and turtles.
- Fish spa. You can dip your feet in one of ten tanks of Doctor fish (Garra rufa). The fish nibble and remove dead skin from your feet and legs.
- Coral and rocky ecosystems with aquascaping and LED lighting.
- Semi-circular tank housing jelly fish

Figure 100 : Aquarium after Renovation

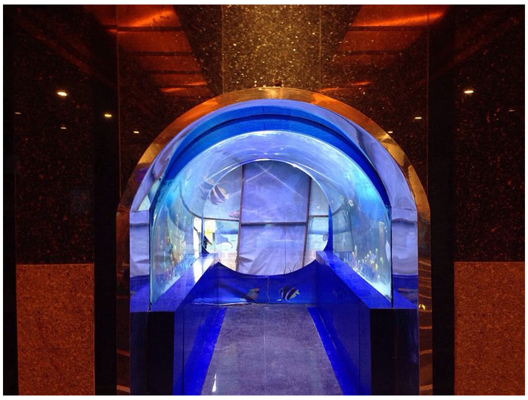
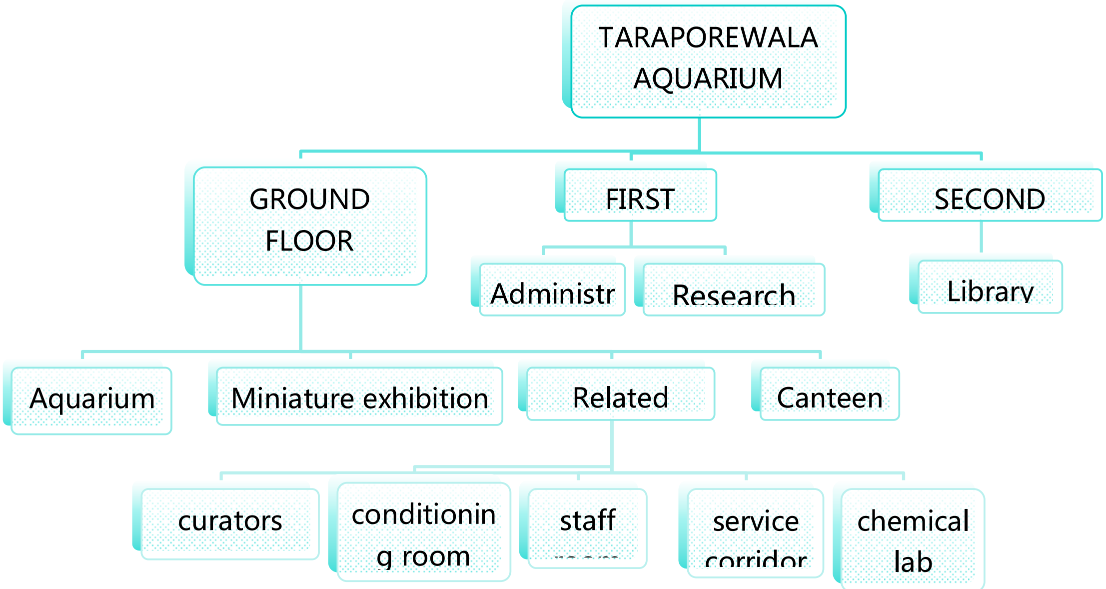


Figure 99 : Acrylic Glass Tunnel

- It was re-opened after renovation on March 3, 2015.[4] The renovated aquarium has a 12-feet long and 180 degree acrylic glass tunnel.
- Another attraction is the special pools, where children can touch fish which are harmless. The fish will be kept in large glass tanks, which will be lit with LED lights.
- 2,000 fishes of over 400 species and has been renovated at a cost of Rs.22 crore (approx Rs 7.5 crore for aquariums and Rs. 16.5 crore for construction work done by Public Works department).
- The exotic fish from overseas has been introduced at the new aquarium the number of new varieties of marine fish at 70.

Figure 101 : Inside View of Taraporewala Aquarium

CATEGORIES OF MAJOR AREAS



1. GROUND FLOOR:

- **ENTRANCE HALL**

Fountain at the further end of hall combines utility with aesthetic as water spurted up enters duct connected with general fresh water circulatory system and is deprived of noxious gases.

CONCLUSION

The entrance hall is utilized only as transition space from main section to miniature section and outside. Although the fountain animates the atmosphere, there still is a 10th of scope for an interior designer to create an underwater effect.

- **ADMINISTRATION :** To the right of hall (south side) are

1) Curators office

2) Conditioning room

3) Staff room

4) Service corridor

5) Small chemical lab.

All specimens either for display or for study are kept in the conditioning tank for observation before introduction into main aquarium tanks. These tanks are also called as quarantine tank wherein specimens are tested on.

CONCLUSION

Insufficient waiting area outside curator's office. Conditioning room has ordinary polished Kotah tiles for flooring.

- **MINIATURE EXHIBITION HALL**

Small fishes corals, worms; coelenterates are kept here in about 1-foot deep fish tanks, as these would be lost in large tanks. Also it has a display of shells, cones and other such items. These tanks are held in wooden partition 1m away from the wall for service purpose.

MAIN SECTION (aquarium)

There are 18 tanks for marine/ salt-water specimens along the periphery which the 9 tanks in centres of hall display fresh water specimens. In all there are 66 tanks with glass frontage 1.1/4 inches thick. Capacity of each tank ranges from 1000-5000gallons. The tank interior is decorated so as to give an effect of natural environment. The tank seems to be literally framed and look like pictures framed in mosaic partitions. The exterior surface is cladded with marble tiles with timber railing preventing visitors from coming too close to the tanks. Display boards on top of each tank give information above contents of the tank. Ventilation of hall is by exhaust fans and there is consideration darkness in the hall so as to highlight the lighted tank inter-view.

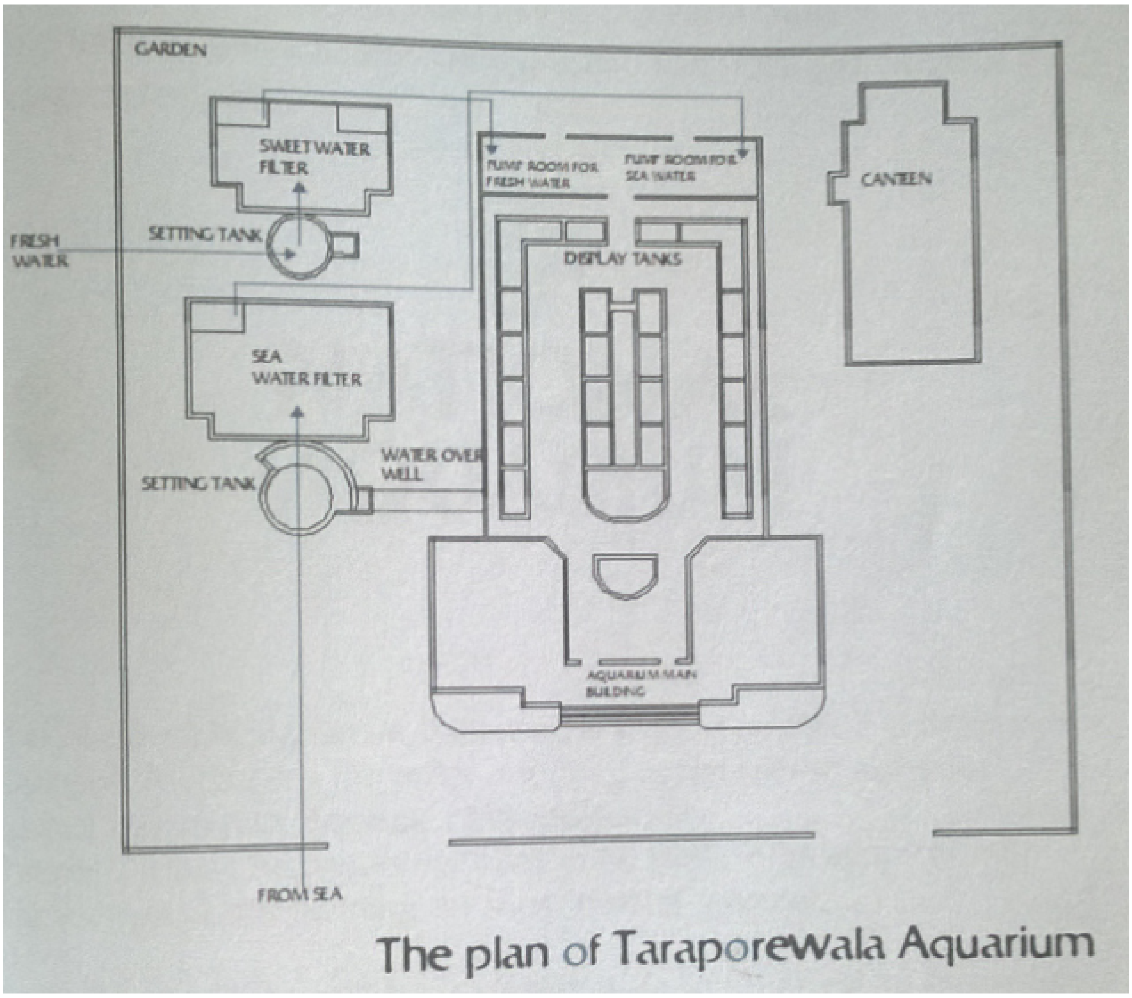


Figure 102 : Ground Floor Plan Of Taraporewala Aquarium

1. **FIRST FLOOR**

It has been set aside for research administration proposes. North end has the marine biological lab. South end has the office of the Director of Fisheries and his staff. There are 2 labs with a dozen research workers and up to date facilities like arrangement for supply of limning sea and freshwater, ducts to ensure proper aeration, gas, paraffin baths and optical instruments and special tanks where specimens can be studied under controlled conditions.

2. **SECOND FLOOR**

The library and offices have occupied it.

CONCLUSION: The first and second floors are now not in a working condition and are shut down temporarily for repair.

SPECIAL FEATURES:

1. ILLUMINATION

The tanks are illuminated by normal tube lights which are hung about 1' to 1 V2' above the water level. The sloping roof above has glass skylight to admit natural light. The skylights were originally tinted pale blue (no longer) to prevent excessive growth of algae in the tanks.

2. AERATION

Elaborate arrangements have been made to ensure a constant stream of air into all the tanks The silvery jet of bubbles spiraling to the surface of the water from the bed of the tanks is compressed air released in each tank. Behind the main aquarium section is the pump/machinery room where pumps and compressors operate the circulatory aeration system. Entire machinery operates on electricity and once the main switch is on the water keeps changing day and night.

SERVICES:

1. RESERVES

Below the mom containing pumps and compressors are two water reserve tank. The seawater reservoir is 3.3m by 14.0m by 43m while the fresh water reservoir 3.3m by 14m by 4.5m The reservoirs receive water from the filtration plant and from here the water is pumped continuously to the respective overhead tanks directly above the pump room. From here it is conducted to the exhibition tanks by gravitation. The piping used here is HDP (HIGH DENSITY POLYMER) type.

2. SERVICE PASSAGE

The service passage behind the display tanks is about 1.2m higher than the public area. It is 1.5m wide with water channel along its one end taking out from tanks to the settling tank. Surrounding the tanks at the back is a service corridor for cleaning of tank and maintenance. It is 1m wide and aptly at a higher level than the display floor to facilitate cleaning and maintenance operations. It has a separate entrance and is not clubbed with general display area. The service area also houses quarantine or holding tank.

CONCLUSION

The service passage has ordinary polished Kotah tiles for flooring lacks non-skid floor finish.

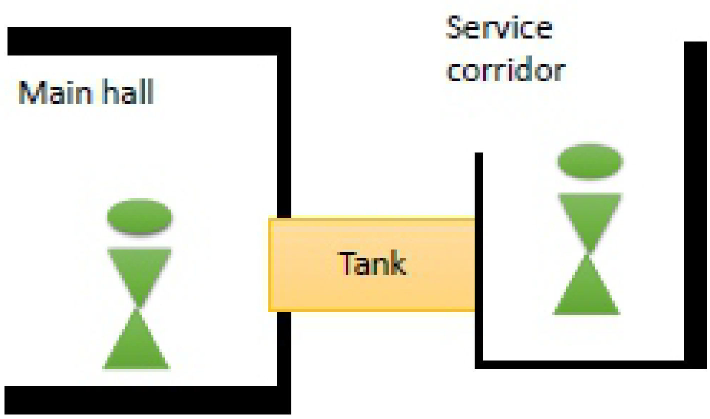


Figure 103 : Service Corridor

PURIFICATION PLANT

The purification plant consists of the settling tank and the filtration plant. The filtration plant is a structure located in the open space on north side of the aquarium buildings. Both the seawater and the freshwater systems have separate underground concrete settling tanks and filtering units. The filters have filtering media of pebbles and sand of varying grades arranged in layers.

Water first enters the settling tanks and then passes into the filter beds. Then both seawater and fresh water flow into their respective subterranean reservoirs. From here water is pumped to overhead tanks and from there it flows to the display by the gravitation.

Seawater is brought to the aquarium from the sea just off the marine drive road. Earlier a barge was used for providing undiluted and unpolluted seawater from a pond far off from the shore at floor tide. Now water is directly pumped. Fresh water is received directly from the municipal water connection.

WATER CIRCULATORY SYSTEM

The circulatory system adopted for changing water in the display tanks is closed system. The same water is used over and again for a period of 1 month. After which new supply is taken. This helps to maintain the ph. and chlorine level in the water and is also less tedious.

The circulation in this aquarium is of closed type i.e. water once taken into the system is used over and over again. From the display tanks it goes to the filtration tank, where it passes through layers of sand, gravel and pebbles. Then it flows to basement reservoir, from where it is pumps to the overhead tank from where it is supplied to the respective tanks by gravity flow.

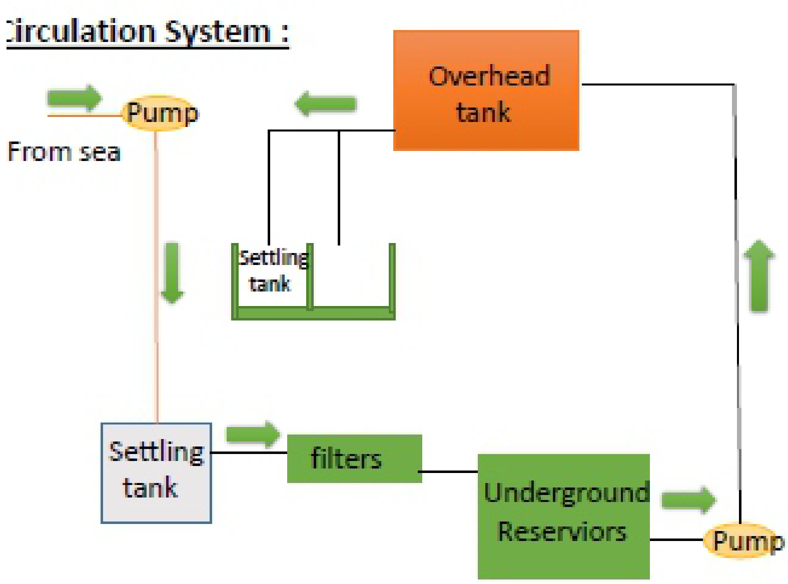


Figure 104 : Water Circulatory System - Closed Type

VITAL STATISTICS

- Area of plot 4136.55sq.m
- Area occupied by garden 620.48sq.m
- Total area 2895.60sq.m
- F.S.I. permissible 1.33
- Area permissible for construction 3860.74sq.m.

The existing structures are inclusive of aquarium and non-aquarium activities

NON AQUARIUM ACTIVITIES

- Annex bldg (inclusive of RDDF by ADF by statistics dept.) 992.60sq.m
- Canteen inclusive of accounts dept. 380.00sq.m
- Garage 43.00sq.m
- Total area of annexes building 1415.60sq.m

AQUARIUM ACTIVITIES

- Taraporewala aquarium 205530sq.m
- Filter tank 34.89sq.m
- Fish food shed 9.84sqm
- Pump shed 12.92sq.m
- Salt water settling tank 158.67sq.m
- Total area of aquarium activities 2271.62sq.m

Area available for future expansion - 165.62sqm

ANALYSIS AND CONCLUSION

- The fish were very interesting but the tanks were not so clean and the lights were clingy. So altogether it didn't make a well managed aquarium.
- Also the sign board/labels that were placed next to the tanks gave a gist of the fish species in English, Hindi, and occasionally in Marathi, but there were lot of proof reading errors in these descriptions, misleading the visitors.
- Another upsetting sight was of the sea turtles' tank. The tanks were alright in height, but were not spacious enough breadth wise, so the poor sea turtles kept knocking their noses to the tanks.
- There are hand rails bordering the tank and limit the movement of visitors and protect the glass. Also each tank is coupled with
- A display describing the respective species.
- The site is well placed opposite to the Arabian sea in the busy marine drive.
- No place for parking is provided.
- Entrance area is congested.
- Has a monotonous display technique.
- Hygiene is neglected and service corridors are not maintained.
- The toilet at the end has a common entrance.
- It is needed upsetting to the note that a benevolent vision made by the founder mr. Taraporewala is not realized in its entirely.
- Building is not made in terms of being climate responsive.
- **Future initiative:** There is a proposal to convert this aquarium into an underwater oceanarium and the government of Maharashtra is working on it. If it is materialized, then people can undertake an undersea walk, surrounded by marine life. Meanwhile, the existing fish needs to be taken care of.

2. MARINE BIOLOGICAL RESEARCH CENTRE – RATNAGIRI

LOCATION:

Bhagwati Mandir Road and adjacent to Mandavi Beach at Pethkilla.

DISTANCE:

a) 8 Km away from Ratnagiri Railway Station.

b) 2 Km away from Ratnagiri Bus station.

ESTABLISHED: in 1958

NO. OF SPECIES: 1300 nos.

AREA: 10 acres

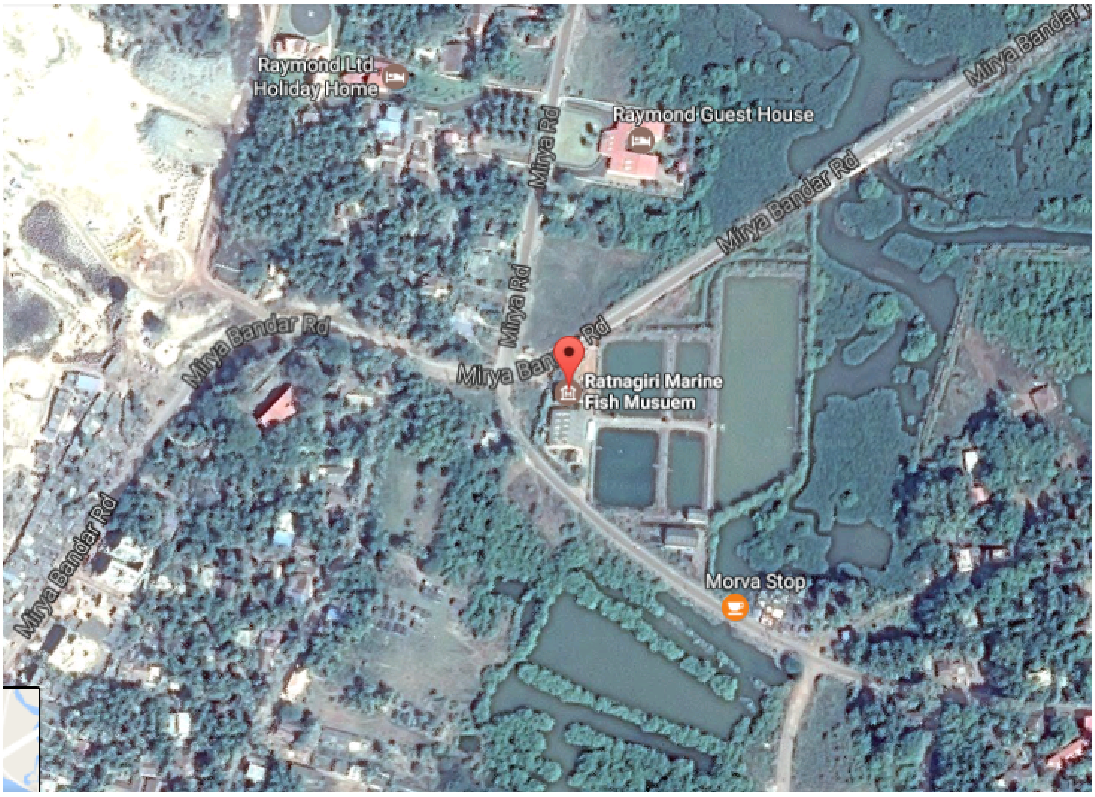


Figure 105 : Location Map of Marine Biological Research Centre

It is well known fact that 'Aquarium and Museum' is working as an important tool for academic students as well as farmers to learn about fragile marine as well as freshwater aquatic ecosystem. It not only creates awareness among the general public about this field but also helps in creating awareness about the conservation of some endangered aquatic flora and fauna of the region. Keeping this in view, Marine Biological Research Station, Ratnagiri established 'Marine Aquarium and Museum' in 1958.

The Marine Biological Research Station, Ratnagiri is one of the premier institutes, especially in the South Konkan Coastal Fisheries Zone, having a mandate for development of fish production technologies, transferring the technologies to fish culturists, entrepreneurs and the industry, and generating professionally trained manpower in fish culture.

The main objectives are summarized as:

- To undertake need based research on marine fishery resources of the Konkan region of Maharashtra.
- To investigate the biology of marine and freshwater animals under controlled conditions.
- To develop suitable technology for controlled seed production and culture of candidate species of fishes and shell fishes.
- To undertake extension work for transfer of technology to fish farmers and fishermen in various aspects of fisheries in order to enhance the production and upliftment of livelihood of the community.

THE NEED/UTILITY OF THE STATION:

- The abundance of marine, brackish and freshwater resources and faunal diversity along the Konkan coastal zone.
- The vast resources in terms of Arabian-sea on west side and 3 – 4 month rainy season are most suitable agro climatic conditions for fish production in the zone. In order to utilize these potential resources for betterment of fishermen, unemployed youths etc. the research station had planned to implement extensive research and extension activities.
- In order to utilize the vast water resources of Konkan and in all of Maharashtra, the need based research and extension activities on the below given aspects is already started and will be continued in the future.
  a. Mud crab culture
  b. Freshwater prawn seed production and its culture
  c. Ornamental fish culture
  d. Reuse of waste water for aquaculture as well as Integrated farming etc
  e. Cage culture in reservoirs,
  f. Brackish water fish culture
- Extension / Demonstration of technologies among the perspective farmers, fisherman, unemployed youths and conduct training programs to generate skilled manpower in fisheries field. The research station is geared up with required facilities to generate the said skilled man power.
- Scientific and technical information on various aspects of fisheries will be made available to general public in Marathi language.
- Priorities will be given to research on culture of Mussel, Oyster, Crab etc. and value added product development as an income enhancement activity of the fisher community.
- Tourism point of view, the maintenance of marine aquarium and museum (which facilitate to
- Create awareness among general public about the fragile and fascinating aquatic biodiversity) is a developing sector in fisheries. However, very little efforts have been made to commercialize it.
- The studies will be carried out to develop the technology package.

Figure 106 : Outside View of Marine Biological Research Centre

- The Government of Maharashtra under the Department of Fisheries established this Marine Biological Research Station.
- Presently attached to Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist.: Ratnagiri.
- Catering development of fish production technologies, transferring the technologies to fish culturists, entrepreneurs and the industry, and to generate professionally trained manpower.
- The research station had total 10 ha area as field facility including three floored building at main campus, a well-equipped 'Aquarium and Museum', a modernized brackish water fish farm, a Mechanized Fishing and
- Research Vessel, Seed Production facilities and various laboratories at its disposal.
- They also do farming of prawns, crabs and different fish.
- This Aquarium also has sea museum which stored/stuffed different fish in glass tubes.

Figure 107 : Inside View of Aquarium 01

Figure 108 : Inside View of Aquarium 02

- At entrance of aquarium they put giant show piece of real ship 'Varsha', which attracts each visitor also in each wall of aquarium they painted different fish photos.
- Comprising fishes, crustaceans, molluscans, specimens, which includes of freshwater, brakishwater and marine water habitat of Konkan coast.
- In this section, along with beautiful and fancy colour fishes, one can also observe locally available freshwater aquatic species like prawns, crabs, turtles, barbs and aquatic plants.

Figure 109 : Giant Show Piece at the Entrance

Figure 110 : Hawaiian Lion Fish

Figure 111 : Sea Horse


Figure 112 : Stuffed Fish 01 **Figure 113 : Stuffed Fish 02**


Figure 114 : Sea Fish Farming **Figure 115 : stuffed fish 03**

This museum also possess well mounted precious and age-old skeleton of Whale. The original length of the whale being 55 feet long and 5000 Kg in weight is strongly appreciated by everyone who visits this station.

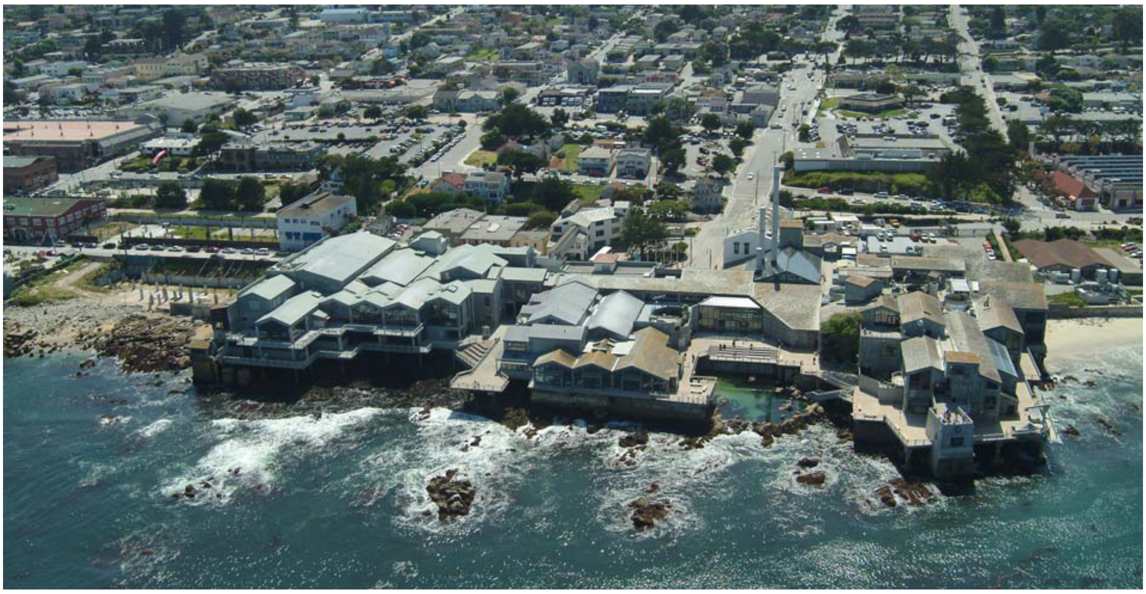
Figure 116 : 55 Feet Long Whale Skeleton 01

Figure 117 : 55 feet long whale skeleton 02

24.9 LITERATURE CASE STUDY

1. MONTEREY BAY AQUARIUM

- Location: MONTEREY, CALIFORNIA.
- Owner: City of Long Beach
- Architects: Esherick, Homsey, Dodge, and Davis
- General Contractor: Turner/Kajima
- Developer: Kajima International
- Exhibit Consultant: Joseph A. Wetzel Associates
- Galleries : Nearly 200 galleries and exhibits are devoted to diverse habitats of Monterey bay.
- Site Dimension : site measure around 3.3 acres.
- Exhibits and other public areas : 175,064 sq.ft. (excludes decks)
- Ocean view Decks : 25,500 sq. ft.
- Total aquarium : 322,000 sq. ft
- Budget/Cost: $55 Million



Bird eye view – Monterey bay aquarium

a. Site Surrounding: Site is surrounded mostly by the hotels and other public buildings.

b. Topography: The Aquarium is built on flat terrain without any contours.

c. Link of site with surrounding: The site is connected with Wave Street.

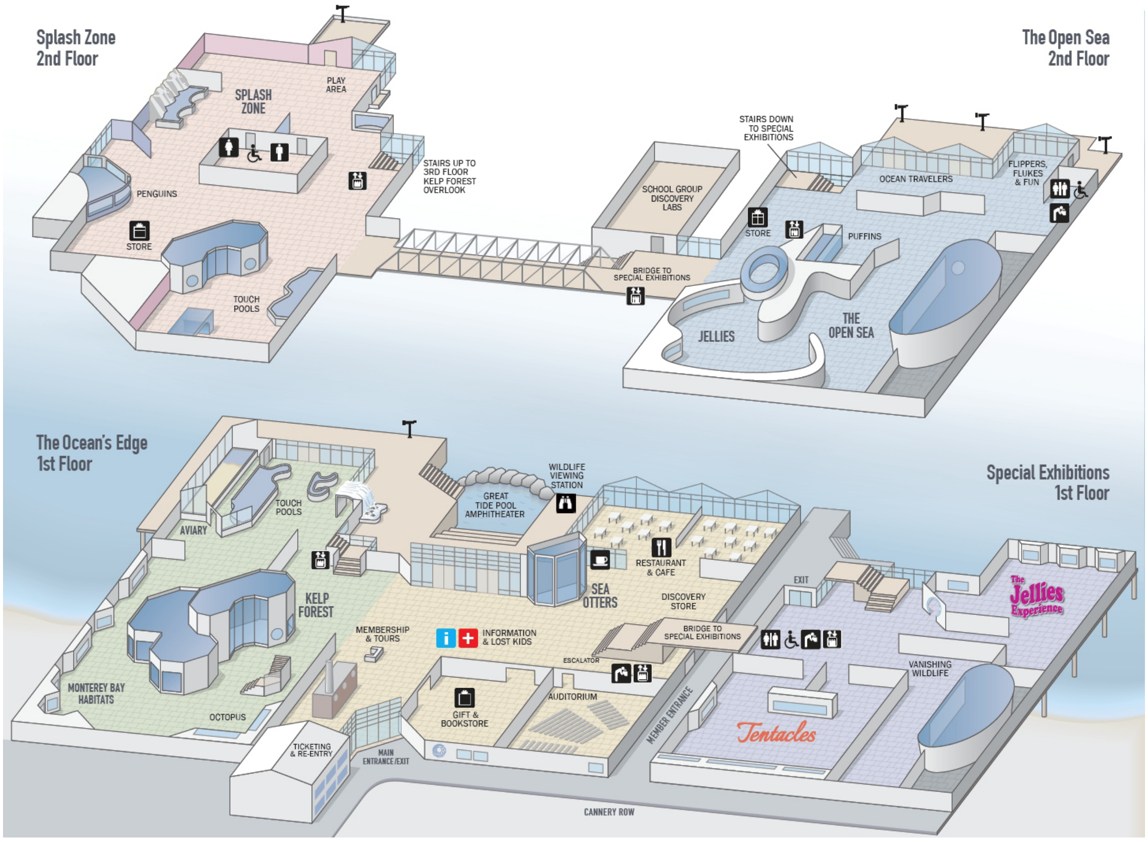
d. Structure in General:

- Building type -low-rise building.
- Foundation System -Pile foundation.
- Façade Material –Concrete and Glass and steel.

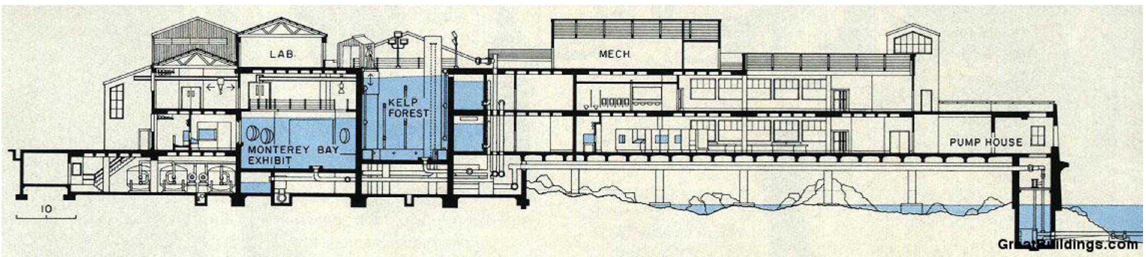
e. Water Body: Monterrey bay is on the rear side of the aquarium.

- The aquarium tries to maintain the architectural character of the canneries on the exterior elevations.
- It also incorporates the natural site into the design of the building and exhibits.
- The original factory pump house.
- **DISABLED ACCESS:** All the exhibits and aquariumfacilities are accessible to people with disabilities.

External view of Monterey bay aquarium



Plans of Monterey bay aquarium



Section of Monterey bay aquarium

DISPLAY:

- The Monterey Bay Aquarium showcases more than 35,000 animals and plants across 550 species. You'll discover all kinds of local wildlife here, including fish of all sizes, invertebrates, mammals and plants.
- The centrepiece of the aquarium is a three-story-high tank containing a towering kelp forest.
- The spectacle of wolf-eels, leopard sharks and schools of sardines gliding and darting through the swaying kelp giants.
- The Open Sea to get incredibly close to enormous sunfish, hammerhead sharks, and blue-and yellow fin tuna.
- On the other side in the Oceans Edge section check out the Giant Octopuses.
- In the Rocky Shores exhibit, walk through a tunnel as waves foam and crash overhead.
- After taking in the larger exhibits, turn your attention towards one of the ocean's more delicate creatures, the seahorse, in the Splash Zone.
- Children will delight in the comical penguin troupes and the sea otters lazing about on rocky outcrops. Family members of all ages can touch and feed a variety of animals while learning about their habitats at the petting pools.
- The auditorium hosts shows throughout the day, most of which are 15-minutes long. Learn about the life of the spineless jellyfish or catch the daily feed with turtles, fish and sharks. Take a trip behind the glass with a short film detailing how the aquarium staff feed and care for all the center's animals.

Interior view of Monterey bay aquarium

SEA WATER SYSTEM:

In the ocean's edge galleries, fresh seawater is pumped continuously and directly from Monterey Bay to maintain the great diversity of plant and animal life in exhibits. The outer bay galleries operate on a "semi closed" system. Water from the main intake lines is piped to the new wing where it is heated to 68 degrees Fahrenheit and circulated through the exhibits.

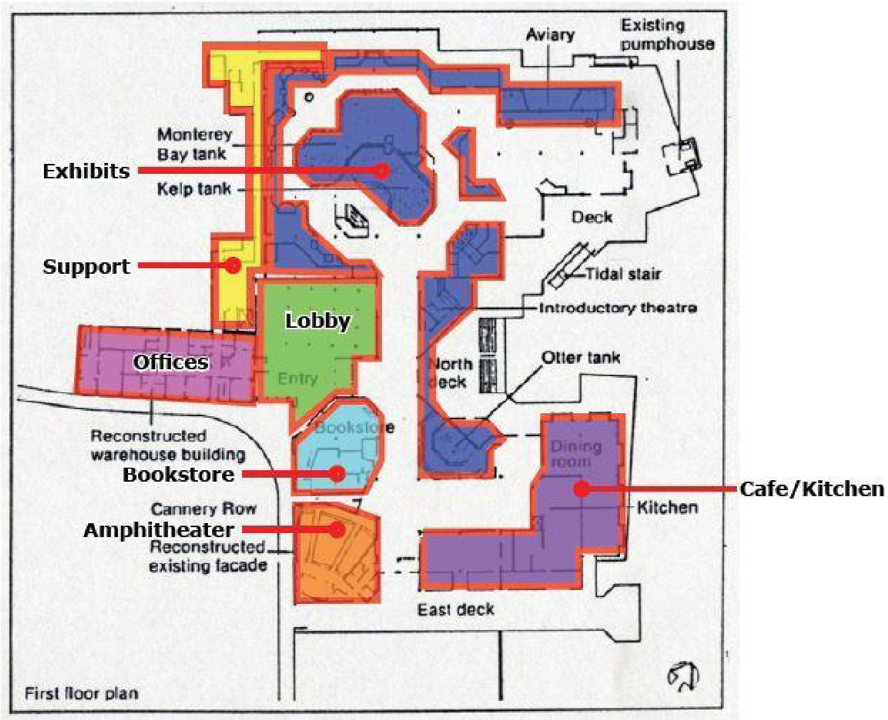
MATERIAL USED:

- Some of the materials that are used to make the building sustainable for all the uses within the facility.
- Often plastic materials are used to help prevent corrosion. Being that many of the exhibits are salt water ones, this is an important factor.
- Also any steel reinforcing is epoxy coated to keep the corrosion to the minimum.
- All tanks are designed with no exposed metal parts.
- A kelp tank, which is almost three stories high is made up of 7 inch thick acrylic panels.
- At the top of the kelp tank is an open skylight, which helps the kelp to grow.
- Another unique element of this aquarium is a stream that runs through the entire facility.
- The stream is stocked with trout and salmon, and terminates in the bay.

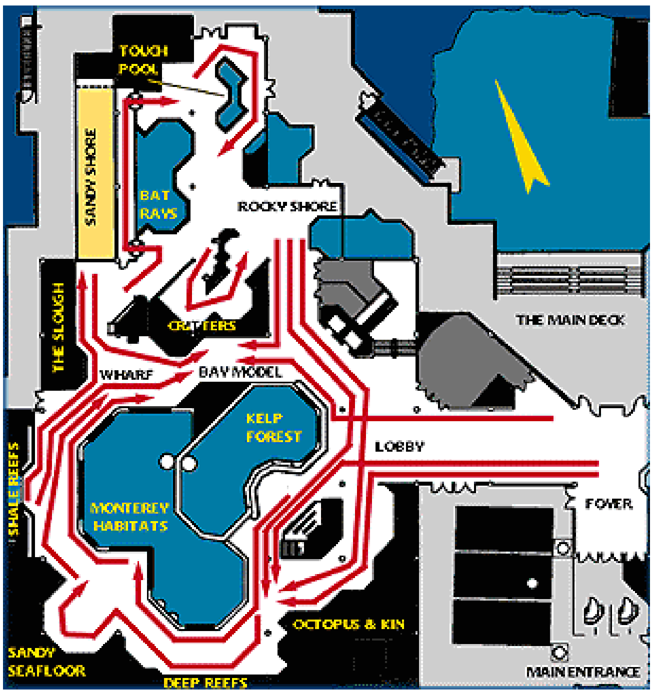
EXHIBITS FACILITIES:

- Tunnel Aquarium
- Marine gallery
- Touch pool
- Species tank
- Splash zone
- Underwater activity
- Museum
- Special exhibition
- Feeding shows
- Conservation center
- Auditorium

Tide pool of Monterey bay aquarium



Programme plan



Circulation plan

2. NATIONAL AQUARIUM, BALTIMORE

PROJECT: National Aquarium at Baltimore

PROJECT ARCHITECT: Cambridge seven associates inc. Cambridge, Massachusetts.
PROJECT COST: $21.3 million

BUDGET: $12 MILLION

COMMENCEMENTS: AUGUST 1, 1978.

DATE OF COMPLETION: AUGUST 1981.

LOCATION: The aquarium is located on Baltimore's harbour front as a part of a plan to revive the harbour. The aquarium and the marine mammal pavilion are connected with a bridge. They are placed on two piers. As these piers just out in the sea it gives an impression of the structure floating on water.

WATER CAPACITY: The aquarium holds more than million gallons of salt and fresh water.

NUMBER OF SPECIMEN: More than 5,00 specimens, representing 500 species of fish, bird, reptiles, amphibians, invertebrates, and plants and marine mammals.

EMPLOYMENT: A full time staff of 225, assisted by a part time staff of 22, works in four operating departments:

- Development and administration
- Marketing and visitor facilities
- Research and animal affairs
- Programs

EXHIBITS CATEGORIES:

The aquarium has uses sophisticated theme exhibits areas as under.

- **Wings under water-**

It is a ray exhibit. Southern stingrays, cow nose rays and blunt nose rays, etc. 50 rays in all can be seen gliding in this ray exhibit. The visitors learn about these striking, mysterious and misunderstood species of the sea while examining theme in their spectacular 260,000-gallon salt-water pool.

• Atlantic coral reef-

Contained in a 13 ft deep doughnut shaped tank, this exhibit features dazzling tropical fishes swimming throughout fiberglass simulation of the coral reef. It holds 335,000 gallons i.e. 15,24,25,000 Lars of water.

• Open ocean-

Also called as the shark tank this oval tank houses several species such as sandbars, sand tigers, etc. it holds 222,000 gallons of water.

• South American rain forest-

This steamy foliage laden stimulation of the South American jungles reproduces the stratification of plant life in a neo tropical rain forest. Over 700 species of tropical plants thrive in the 64 ft. tall glass pyramid atop the aquarium. It also contains 25 species of fish including tetras and piranhas. It also houses over 30 brightly colored tropical birds such as hawk headed parrots, blue crowned mot-moths and tanagers.

• Sea pool-

70,000 gallons i.e. 318,500 liters, capacity pool houses numerous harbor seals and a pair of gray seals.

• Surviving through adaptation-

This exhibit consists of 22 galleries. The visitors experience the complex and often beautiful adaptations of various marine animals and to discover how these adaptations help the animal to survive in its environment. These include the following:

a. Long fish and their defensive spikes.

b. Deep-sea pinecone fish and their bio luminance.

c. Sea anemone and their brilliant colors.

d. Octopus and their giant specifications.

e. Electric eel.

• North Atlantic to pacific gallery-spans planets oceans.

The children cove on this floor allows visitors of all ages to handle inter tidal marine animals. Computerized display depicts effects of human activity.

• On tropical rain forests.

• Mountains to the sea.

1. Allegheny mountain pond

2. Tidal marsh exhibit.

3. Coastal beach.

4. A simulation of the Atlantic shelf.

• Noteworthy places:

1. Habitat theaters-slide shows daily

2. Amphitheater —1300 seats

3. Auditorium-275 seats

4. Pier 4 gift shops

5. Puffin place (souvenirs and gifts and educational material)

SERVICE AREAS:

Since water borne site precluded placing the aquariums extensive mechanical services and staff areas below grade these occupy the plaza level and one level below. Public places are introduced by a pyramid capped raised platform. Services occupy an area of more than 50% of the total aquarium area.

SPECIAL FEATURE:

It has an unusual multi layered display system. The design is based on one-way route leading visitors upward into a rooftop green house and then downward within the center of a two level ring tank. Specially designed elevators for handicapped persons to enter the building through the members, entrance on wharf level. To create the moods of the undersea world they used all the tools available for advanced exhibit design and audiovisual communication and taped sound effects.

EDUCATIONAL PROGRAMS:

The aquariums department offers three major types of programs for the Maryland school children in kindergarten through college. In classrooms program school visitors discover animal adaptation by examining living animals and artifacts. Gallery classes explore the ecology of the aquariums and habitats, and the auditorium programs use slides, films and props too focus on specific group of animals. Training programs at the aquarium includes college internships and volunteer positions for community residents.

AIM:

The aquarium is committed in making known the unity of life through water with a combination of recreation and educational and research programs. The aquariums main form is conceived as a device for the organizing a progression of the experience so involving that you forget the architecture. Within the building the orchestration of exhibits is so merged with their visual and spatial framework that the architecture becomes invariably a part of the visitors, an within the building the orchestration of exhibits is so merged with their visual and spatial framework that the architecture becomes invariably a part of the visitors, an experience. Cambridge seven, the planning team, aimed from the very beginning to plan the aquarium and its contents to give an experience more engaging than just staring at the incurious gaze of the fishes in the tanks. The subject was conceived to be not the ocean alone or even any contained water bodies such as lakes, rivers, ponds etc. but water itself as the basis of life. The various exhibits accordingly combine the best of the zoos in the form of display of a wide range of aquatic life, mammals, birds. amphibians and plants as well as fish. The aquarium combines these displays with the natural history museums through pains taking elucidation of the inter-relationships among species in complex ecosystems.

STRUCTURAL ANALYSIS:

The building is a complex mass of the steel and reinforced concrete, build up to seven levels. The building sets an image of a huge sea bird gracefully afloat. The structure is visible from all sides and each view adds to the overall composition. The building is built on a pier and seems perched on it. Internally the aquarium is designed to have a five level atrium gallery, which at the top is covered by a triangular glass pyramid. This pyramid houses a simulated rain forest. Mother major exhibit is the interlocking oval shaped ring tank. On the exterior side of the building are located the smaller areas such as the auditorium and an elevated entrance platform sheltered by a smaller glass pyramid. The building has a total footage of 115,000 sq.ft.

CIRCULATION:

The raised platform capped by a glass pyramid roof forms the entrance to the visitors. The platform is raised through overlook the inner and the outer harbors, the city skyline, and the flag are bedecked fore court of the aquarium itself. From the lobby situated adjacent to the entrance starts a unidirectional continuous path through the building. The unique circulation pattern is the key of the entire display orientation. The path zigzags up through the central atrium lined by exhibit galleries, and emerges at the roof top where there is situated the rain forest simulation, it then winds down again via zigzag ramps through the center of the huge ring tank.

DETAILED CIRCULATION:

On entering the lobby area the visitor first encounters a water toy, transparent tubes of bubbling and gurgling blue water that screens the if shop beyond and deflects the incoming traffic away from the out bound circulation stream. As the visitor enters the main exhibit area, he then passes in to the silence and the shadows of the underwater world; a soaring cavern crunched with balconies and docks and rises crossed by up reaching bridges. Just below the bridges one stares into the pond where the dolphins covert. Further across the way dark silhouettes continue to glide sinuously at the eye level, this is the horrifying preview of the shark pool. All around this place are the underwater illuminations of the dolphin pool th4e undulating neon lights that warp the ring tank. Inside and outside, and the colorful glow of the surrounding exhibits. These are in turn picked by the reflective surfaces of the ceilings and the under side of the ramps, bounced back to the never still water of the pool, and diffracted into kaleidoscope play of moving light and colors. The visitors continue to follow the upward spiral, through exhibits galleries edging the central space, crossing the void with each change in level. The flow of circulation is clear but is not insistent. To prevent museum fatigue and to hold on to the spirits of the visitors the upward path progresses along an ABBA rhythm. In this the sensual and the intellectual elements of the detailed exhibits are encountered by the complimentary expansiveness of the space itself. If the visitor is tired physically or mentally he can drop out of the path to loiter in the cul-de-sac or he might ease himself off by just gazing down at the dolphins cavorting in the luminous pool below the bridge. The dolphins at any point form a point of reference before being beckoned onward to glimpse the exhibits around the next bend. The upward journey terminates into a major suspense in the form of the dense and humid jungle of the rain forest, the visitor descends to the surface of the water in the ring tank and the warp, around the painted horizon, before drifting down thaw enclosing tanks and the depths. The visitor witness the first mystery of the deep oceans in the form of coral reefs, which's brilliantly, colored inhabitants scoop and dart under the occasional shadow of more formidable fish. The sinister forms of sharks and rays surround descending father down the visitor before moving gracefully onto a lower expanse of the windows looking from underwater to the dolphin pool. The final lap is up to the lobby level, where summary exhibits traces the role of man as explorer and exploiter of the fragile life giving sea.

ANALYSIS OF THE AQUARIUM:

POSITIVE POINTS:

1. In the entire scheme water is used as a main design element, a pond and a stream in the rain forest a water toy screening the gift shop at the entrance etc.

2. The circulation inside the structure being unidirectional, the incoming crowd does not merge with the outgoing crowd and a continuous flow of visitors is maintained.

3. The ARAB rhythmic progression of the tanks i.e. the sequence of smaller tank following a larger tank and than again a larger tank holds the attention of the visitors as it helps to break the monotony of viewing the exhibits.

4. The structure is the combination of different forms but given complete justice as regards to their importance. The exhibit galleries forming a part of the octagon. The rainforest forming a triangular tiara. The descending coral and the shark tanks are oval in shape. The educational area is a triangle.

5. The different sound and visual effects accentuate the movement inside through the exhibits. Thus making the visitor feel the reality inside the space and to make his trip a memorable one.

6. The provisions for the disabled are adequately considered.

NEGATIVE POINTS:

1. The structure has a boxy and bulky appearance; does not compliment with the seascape.

2. Even though the structure is dedicated to the ecosystem, it does not show any consideration to nature due to its bulk

3. The site seems to be constrained and overcrowded.

4. The circulation inside the aquarium winds up to the rain forest, which thus gets the most importance and then unwinds down towards the exit. Hence it fails to give the visitor a feeling of traveling through the depths of the oceans.

PROJECT STATISTICS:

TOTAL Designated Site Area	14845 sq. mts.
Plaza Area	8178 sq. mts.
Building Foot Print	2786 sq. mts.
Total building net Square Footage	1967 sq. mts.
Total Building Gross Square Footage	13296 sq. mts.

BREAKDOWN A

Public galleries / lobby (Public Circulation Only)	3039 sq. mts.
Exhibit (includes Habitat Only)	1967 sq. mts.
Administrative (Curatorial Research and Offices)	1414 sq. mts.
Building / Exhibit Support (Building Mechanical, Life Support Mechanical and Exhibit Back-up)	6821 sq. mts.

BREAKDOWN B

Exhibit and public circulation	5036 sq. mts.
Lobby and public facilities	800 sq. mts.
Auditorium and support area	340 sq. mts.
Educational / Curatoria / Research	619 sq. mts.
Administration / Staff	829 sq. mts.
Service / Maintenance / Food Services	907 sq. mts.
Mechanical Systems (Building Maintenance and Support	3301 sq. mts.

Mechanical)	
General Building Circulation (Does not include public areas)	1463 sq. mts.

TOTAL GROSS SQUARE FEET = 13296 sq. mts.

OCEANS PAVILION (PAROUE DAS NACOES)

PROJECT: OCEANS PAVILION, LISBON, PORTUGAL

PROJECT OWNER: PARQUE EXPO '98

ARCHITECTS: CAMBRIDGE SEVEN ASSOCIATES

ASSOCIATE ARCHITECT: PROMONTORIO ARTCHITECTOS ASSOCIADOS

ENGINEERS: OW ARUP AND PARTNERS

DESIGN/BUILD/STARTUPS: IDEAIENGIL

HABITAT BUILDER: DAVID.L.MANWARREN

PROJECT AREA: 215,000 SQ.FT. FOUR STOREY EXHIBIT AND MAINTAINENCE SPACE TWO STOREY ACCESS BRIDGE. ONE STOREY SUPPORT BUILDING

COST: $ 70 MILLION

A single idea is that all of the world's oceans form one great sea. , the theme and unifying element of the oceans pavilion a primary attraction at Portugal world expression _ expo 98 a huge, 1.22million-gallon tank 110 feet square and almost 110 feet deep, lies at the heart of the pavilion, informing the architecture and organizing the aquarium around the central concept; the inter-relationship of global waters.

This force coincides with that exposition theme; the oceans- a heritage of the future.

The new aquarium, Europe's largest, offers an emotional experience that's more theater than science. Peter Chemayeff of Cambridge seven associate, which designed the aquarium says,' the oceans pavilion may provoke controversy among those who will say this isn't a strictly scientific presentation. But there shall also be those who will say:' yes, this is scientific. It makes a point of the unity of the earth’s oceans.

THE AQUARIUM AS A THEATRE

As in contemporary theatre the interior architecture is intended to disappear, focusing attention on the fritted glass provides different light levels at each corner of the building after a complete tour of the upper zone the path drops one level to the ocean floor for submarine views of the four ocean, as well as the sharks, rays, sea turtles, mackerel and other creatures in the main tank. Altogether there are 8000 specimens and 250 different species swimming in 1, 56 million gallons of ocean water.

The lines between underwater life and the human realm are blurred. Remarkable optics, heightened by controlled internal lighting, allows clear views through the 12 to 14 inch thick acrylic walls. As a result, fish from opposing oceans seem to coexist in a single visual field. The effect is surreal cold water sharks seem to glide by tropical fish in a seamless dance.

Plagues and description of the marine life have been kept to a minimum the pavilion is not overly didactic. Instead visitors experience the marine species in a series of meeting places in the contemplation rooms- quieter, more intimate spaces with smaller focused views, located on the lower level- visitors concentrate to watch music.

Visitors come and go via a covered ramp, a dual level bridge that connected the water surrounded aquarium with its land-based sister building. Ticket sales are housed there along with the shops, offices, galleries, and a conference area. Lining the long high wall that organizes the support building is Ivan Chemayeff's giant mural of ocean life. High and low tech combine in the mural, which uses 60 variations of hand painted blue and white Portuguese tiles to maintain the computer screen pixels.

CREATIVE CONSTRUCTION

The S70 million oceans pavilion had an unusual genesis, the result of a unique design and construction collaboration that extends the understanding of the term design build. Chemayeff also serves at president of IDEA INC. a separate company that provides turnkey services beyond architectural design. IDEA produced feasibility studies and oversaw exhibit planning construction, staffing, and training for aquarium and even the choice of sea creatures. The partnership of IDEA and ENGIL set the budget and guaranteed a fixed price for construction.

According to Peter Sollogub, Cambridge's sevens principal- in charge who worked on the project from the beginning, construction was complicated by the work habits of the Portuguese. Which are different from those of the American builders?

"They don't really use shop drawings in Portugal", he says," This is a product of handicraft". But the team product the project within the budget, and the aquarium was one of the first major structures ready for explosion, which opened its gates in May.

Following the world exposition cruise, projected to reach a peak of 80,000 visitors per day, the pavilion will be renamed the Oceanarium de Lisbon and the remaining open as a public aquarium. One million people are expected to visit every year. Other significant infrastructure that will remain after the exposition closes in September include a 840 acre urban development project called EXPO URBE, which combine 1,850 residential units, hotels, and office development, rail lines, including a station designed by Spanish architect Santiago Cxalatravea and a bridge across the Tagus river should encourage new horizons for Lisbon and for Portugal.

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