Tenualosa ilisha (Hilsa) is one of the major clupeids found in the Indian subcontinent. The range of the Hilsa ranges from Persian Gulf to the waters of Myanmar. It has major fishery and economic importance for rich flavour and high nutritive value. Belonging to the Clupeidae family, a major group of fishes, the fish stay in large schools having silver bellies and a little greenish back. With no spines in their body, a deep forked tail and large scales. The clupeids account for 15% of the total fish catches from inland and marine zones. Majority of them is used for consumption, while many are used for various products of pharmaceutical and medicinal purposes. The oil from its flesh adds a special flavour to for the food bugs and the oil extracted from the fish is an important by product for various industries. Around 160 species from 50 genera are included in the family Clupeidae, surely giving it an important place in the fisheries in most of the tropical countries. The distribution of clupeids can be found from Temperate to Sub-arctic areas ranging from Atlantic Ocean to Bay to Bengal. The family is divided into different species having different habitats and niches with distinctive habits and preferences ranging from freshwater to brackish and marine waters. The spawning quality of these different species differs variedly from each other; some breed in spring, some are breeding in early summer and some breed in monsoon. The food resource of these clupeids is mostly dependent upon the zooplanktons chiefly comprising of copepods, crab larvae, molluscan or fish larvae. Taking the brackish water into consideration where most the clupeids are in their habitats, despite the heavy flow of water, wider saline conditions a very fertile part of water is formed because of the intermixing of freshwater and marine

waters and most of the fish fauns takes refuge. Temperature also plays a major role in migration of Hilsa as they prefer 27 - 35°C, even during the winter months. *Tenualosa ilisha* was first classified in Vishakhapatnam and was given the name Palash, and was given the first description. Later by Hamilton in 1822, it was classified as *Clupanodon ilisha*. An anadromous fish, spending its lifetime in estuarine or brackish waters and for the purpose of spawning or breeding they move into the freshwaters during the monsoon seasons. Talking of *Tenualosa ilisha*, its distribution is from Iran and Iraq in the Persian Gulf to the west coast of India in the Arabian Sea and on eastern coast the Bay of Bengal. The observations made in the states of India are Tamil Nadu, Andhra Pradesh, Orissa, West Bengal and Gujarat has proved that Hilsa breeds in the upper stretches of estuaries or rivers where the water is freshly available. The adult Hilsa is of silvery colour shot with gold and purple. The young ones are usually of a bronze colour along the back, with silvery sides and a burnished silvery band going from above the eye to the upper half of the caudal fin, and the caudal fin is often deeply edged with black in its entire circumference. Caudal peduncle as long as deep Dorsal fin with soft rays originated in the anterior half of the body without caudal and located slightly anterior to pelvic fin. The pectoral reaches to above the origin of the pelvic. Pectoral and pelvic fins are with auxiliary scales. Hilsa is a heterosexual species in which female grows faster than male and the body of female is broader than the male with larger girth. Urino-genital opening of the gravid female is flat but narrow in the case of male where papillae are comparatively prominent.

Hilsa is considered to be a major food source in India, Bangladesh, Pakistan and the countries around Persian Gulf occurring in rivers and estuaries an essential part of fisheries. It is observed that the fish first spends its initial phase of life in the lower reached of the rivers or the mouth of the estuaries and goes to the sea by third year. It has been observed that the Hilsa don't move far off into the deep seas but usually stays in the estuaries or foreshore areas so that with the arrival of monsoons and filling up of the rivers with heavy flow of freshwaters they can move deep into the rivers to spawn and breed.

The migration of Hilsa (shad) is of two types:

1. Monsoon migration: The anadromous character of Hilsa is one of the main factors behind such migratory pattern. During consequent flooding of the rivers, the Hilsa swims against the tide and goes to the river for spawning and breeding.
2. Winter migration: Not only in monsoon, the Hilsa migration is recorded to winter season for a short period of time. The period is from February to March.

The Hilsa, being anadromous in nature follows a life cycle that follows the pattern of breeding upstream and the larvae hatching from the free floating eggs. The immature young stages grow in river channels and descend to the sea for the period up to growth to a mature male/female stage before returning to the rivers for breeding to complete the cycle.

The present work has been done to establish the fish and fisheries potential of Hilsa and to understand the population dynamics and analyzing of its nutritive value with relation to its migratory behavior as no such work has ever been undertaken in the past from the West coast of India.

The objectives set in the work has been set from understanding the diversity of *Tenualosa ilisha* in the marine and freshwaters in the South East Asian region and classification of the Hilsa by both morphologically and at molecular level. Thereafter, the fishery ecology and stock assessment of Hilsa has been done and bio-assay studies related to GSI and HSI index.

In the first objective, the diversity and spatio-temporal distribution of Hilsa has been done. On the basis of secondary data and literature survey, evaluation of distributional status was done for the entire Indian sub–continent and other adjoining areas like the Persian Gulf and varied areas of Myanmar. In Gujarat, the major rivers surveyed were Sabarmati, Mahi, Narmada and Tapi but the major focus was on the availability of *Tenualosa ilisha* in the Narmada River, Gujarat because of the major obtainability and establishes regular fisheries in this river. Pilot survey along the river from the Saradar Sarovar Dam to Jagheswar, at the mouth of the estuary was done to assess all the possible locations of Hilsa landing centre and False Color Composite cartographical map was prepared with the help of USGS, Bhuvan and ArCGIS software. The map clearly depicts the landing centers, fish available and unavailable areas in Narmada River. It is also seen that the northern bank of the Narmada River mostly constitutes the landing centers of Hilsa because of the topographical structure of the river bed. Higher rate of

sedimentation in the south bank makes the fish easier to swim near to the north bank and as a result major catch haul of Hilsa is in northern side.

The second objective is about the taxonomical classification of Hilsa. After establishing the diversity records in and around the waters of Gujarat, it was observed that only the species *Tenualosa ilisha* is found pre-dominantly while the other two species *Hilsa kelee* and *Hilsa toli* were not recorded. As per the literature survey, both these species are more known to prefer marine regions for breeding and spawning. The morphological identification was further confirmed by molecular method, DNA barcoding. The two sequences of cytochrome oxidase subunit I (COI) and 16S gene of different specimens of *Tenualosa ilisha* collected from different places in and around Gujarat were studied. The sequenced data was analyzed by pooling the data for COI and 16S rDNA submitted from anywhere around the world and phylogenetic trees was constructed using MEGA 10 software which aptly showed the closeness of all the specimens though it can hypothesized that the different samples of Hilsa taken for molecular studies might belong to different subpopulations as for most of the them separate clades were formed. It is already discussed that Hilsa after breeding and spawning in the freshwater don’t move faraway in to the high seas and generally move in shoals near the estuarine regions of the rivers. So a possibility of having separate genetic variation cannot be nullified among all the specimens.

The third objective covers the fisheries and stock evaluation of *Tenualosa ilisha* in the Narmada River. It was obtained by understanding the population dynamics by working on the length-weight relationship, condition factor and other statistical

tools of establishing the fishery relationship of male and female Hilsa. Further the data was accessed from the Department of Fisheries, Government of Gujarat which shows the stock capacity of *Tenualosa ilisha*. It was observed that the positive correlation was found for the length-weight relationship and on the relative condition factor or the well-being of the fish. Though the annual catch estimates perceived that the Hilsa catch at the inland waters of Narmada River has seen a decline and reasons which could be attributed for the same are: 1. Less amount of rainfall, 2. Higher sedimentation rate caused by erosion at the upper reaches into the waters of Narmada River, 3. High pollution load into effluent channels by the industries along the course the river, and 4. the plankton and other macro invertebrate population must have decreased leading to food crunch.

The fourth and the final objective cover the bio assay studies of *Tenualosa ilisha* wherein the proximate analysis involving the protein, moisture, fat and ash content was carried out. It was clearly observed that with change of place and according to size during inward migratory route, the proximate composition changes considerably. Hilsa was also a protein rich fish. In different size groups of fishes were found and that were subdivided into male and female Hilsa. The moisture content varied from 35 – 67 % in male Hilsa while in females the variation was observed from 42 – 74%. The lower the percentage of water in fish muscle, the greater are the availability of lipid and protein contents and so would be the higher energy content of the fish. With reference to the ash content of fish muscle, around 0.5 – 1.6% was observed in male and in female it was observed for 1.1- 1.65%. It can be ascertained from the present result that Hilsa good

source of minerals like calcium, potassium, zinc, iron and magnesium. Further, the Gonadosomatic index (GSI) and Hepatosomatic index (HSI) studied for fishes caught during pre-, post- and monsoon seasons. The results clearly depicted the GSI and HSI levels always more in females while in comparison to males. Though while observed closely, in females both the indexes reduce down drastically for its spawning and breeding behaviour and in post monsoon after the eggs are completely spent, the levels reach drastically down. It can be attributed to the lower levels of energy and availability of less food and higher turbidity in the river, the food resources are only available when the fishes reaches the mouth of the river.

This entire work can be evaluated as the first attempt on filling up the lacunae behind the fishery status of *Tenualosa ilisha* in Gujarat. It can further emphasized that with the improvement of fishing laws and regulations and awareness among the fishermen community for the proper time for fishing, the declining population of Hilsa in Narmada River can be further raised back so that it can add to serve as a major economic boost to Gujarat state whose major focus has always been on the marine fisheries sector.