

GROWTH AND DISPERSAL OF RAZOR CLAM *SOLEN DACTYLUS* IN THE MUFLATS OF INDUS DELTA, SINDH COAST (NORTHERN ARABIAN SEA)

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ABSTRACT: The Razor clam *Solen dactylus* is being harvested for the last 10 years from mudflats in creeks of district Thatta. The results of water and soil quality samples indicate the suitability and support for growth, dispersal, production and reproduction of *Solen dactylus* occurring in Indus delta eco-region. Water quality parameters of creeks indicated the ranges of temperature of water and air 11 to 30 °C and 12 to 42°C, pH of water between 8.2 to 8.9, alkalinity of water 267 to 480 mg/l, hardness of water 620 to 1150 mg/l, salinity of water from 22 to 33 ppt. The soil samples of mudflats indicated silt clay 15 to 30%, sandy clay 20 to 40% and fine sand 30 to 40%. Spring, summer and early winter seasons are suitable timing for harvesting razor clam. However, winter cold and rainy seasons are not suitable for razor clam fishing. In winter, the animals become inactive and remain in deep burrows and do not come to the surface. In period of rainfall the razor clam holes were filled with fine silt thus large number of razor clam were affected and even deaths may have been caused if mudflats were exposed at the time of rain.

The recorded mature size of razor clam ranged between length of 6 to 3.5 cm and weight 12 to 40 grams. A trained person dig-out 1.5 to 3 kg of razor clam in 1²meter square in 20-40 minutes. Thus a person can exploit 10-20 kg of razor clam in a period of 3- 4 hours, hence 15 - 20 kg of live razor clam can be harvested in a day or night by a person when mudflat become exposed after tidal action. Coastal communities inhabiting creek areas are engaged in its harvesting using traditional techniques of using salt and probing with thin sticks and hauling razor clams from burrow during low tides when mudflats become exposed. It is concluded that Razor clam is an ecologically important group of marine organism, lives in mudflats and creek systems. Although the razor clams are not locally consumed by native people of Pakistan but it is a fishery having export value which foreign exchange earned by exporting it to South East Asian countries.

KEYWORDS: Growth; dispersal; razor clam; *Solen dactylus*; Indus delta; Arabian Sea

INTRODUCTION

The *Solen dactylus* (Razor clam fishery) were harvested from the mudflats in the Indus deltaic creek system (northern Arabian Sea). *The commercial clam species Solen dactylus* (Cosel, 1989) currently occurs in the mudflats of taluka Keti Bandar and Mirpur Sakro area near Bhambhoor, Darya Peerabad and other Indus deltaic creeks. The

harvesting of genus *Solen* is in the mudflats of Indus deltaic area is being practiced for last 10 years. It is exported in live and in frozen form to Southeast Asian countries. Coastal communities of the creek areas are engaged in its harvesting using traditional techniques of using salt and probing with thin sticks and hauling razor clams from burrow during low tides. In the harvest all members of families including men, women and children are engaged. Seven species of Razor clam are reported from Pakistan but three species *Solen truncates*, *S. dectylus* and *Cultellus cultellus* are of commercial importance (Tirmizi and Zehra, 1982). The species were reported earlier probably 30 years ago by researchers and taxonomists (Saeedi *et al.*, 2013; 2009; Mahadevan, 1980; Alagarwami, 1966, and Virabhadra *et al.*, 1961). However, the *Solen regularis* mostly found in western part of Sarawak, Malaysia (Rinyod and Rahim, 2011). The *Solen marginatus* occurs at the coasts of Atlantic, Europe, northwestern part of African coasts, and Mediterranean Sea buried under the sand and tidal areas, both in intertidal and sub tidal parts at mud substrates and the sands (Hmida *et al.*, 2012). In Indonesia genus *Solen* found in Maduranese coast. Armonies, and Reise, (1999) worked on the population status of clam species at Indian coastal zones. Saeedi (2009) gave the information about the growth performance of Razor clam from coastal region of Gulf Iran. Razor clam lives in or on the mudflats and can be found in a wide range in coastal creeks of Sindh and Balochistan. The clams are active filter feeders and feeds on algae, bacteria and other organic material in seawater.

The razor clam possesses an effective mechanism to escape predators. The razor clams can go down up to 30 cm deep and can move up to half meter by using its foot.

Information on Razor clams, their bio-ecology and fisheries in Pakistan is deficient hence efforts are needed for research studies and data for sustainable utilization of this viable fishery. Present research will be useful for the researchers and policy makers for the initiation of management and conservation of clam fisheries in the country.

MATERIAL AND METHODS

The present research work is of applied nature based on field work (data collection and preservation), laboratory work assessment, analysis and identification of the collected samples. *Solen dectylus* species mostly grow and develop in fertile saline mudflats in the coastal area of district Thatta and other deltaic creek areas. The surveys were conducted on Phitti, Waddi Khuddi, Khai, Pettiani, Kunn Chhino, Hajamro, Naagri, Turchhan and Khobbar creeks. After survey four stations were selected for this study. Station 1 (Phitti creek) Wind Energy (Descon Company) mudflat (24°41'54.178" N, 67°29'23.558"E). Station 2 (Waddi Khuddi creek) Darya Peerabad site Katiyar Jo Tar (24°38'42.204" N, 67°30'23.664"E). Station 3 (Hajamro creek) Hajamro mudflat near village Ayoub Dablo (24°7'12.276" N, 67°23'49.518"E). Station No. 4 (Khobbar creek Mashado, 24° 3' 25.782"N 67° 25' 38.19"E) (Fig.1).

The GPS coordinates of the locations were recorded during surveys using GPS device. Temperature (°C) of air, water and soil were measured by mercury glass thermometer. Thermomter was dipped into the water to a depth of 8 to 10 cm for 2 to 5 minutes during tidal action at the time water was covered habitats of clam fishery. While for soil temperature measurement, the thermometer was entered in soft mud soil in depth

of 5 to 10 cm in mudflats. pH reading of water and soil was measured with pH meter model Orion 5 star (Germany). Before using, the meter was calibrated according to instruction manual provided by the manufacturer. Water and soil samples were taken from sampling sites in sterilized glass beaker for determination of pH readings. Salinity and Total Dissolved Solids (TDS) were measured with digital salinity meter model Orient 320A thermo- scientific. Water samples were taken from sampling sites into glass beakers. The probe cell was emerged in sample for record of salinity and TDS levels. The dissolved oxygen was measured with the help of digital DO meter Oxi-3 model 420A.



Fig. 1. Location points of razor clam occurrence at Darya Peerabad and Keti Bandar.

Soil samples were collected in sterilized plastic bags. The sediment samples were sent to laboratory for the analysis of soil texture. The clay and silt fraction was determined by modified Hydrometer method (Bouyoucos, 1962; Beverwijk, 1967). And the suspension so. The volume was raised by adding l. The solution was transferred into

The sediment samples were sent to laboratory for the analysis of soil texture. The clay and silt fraction was determined by modified Hydrometer method (Bouyoucos, 1962; Beverwijk, 1967). The 40g of soil sample was taken in to 500 ml beaker. 40 ml of sodium hexameta phosphate (10% solution) and 150 ml of distilled water was added then the solution kept for overnight. Next day the samples were stirred well and transferred into 1000 ml graduated cylinder. The volume of soil suspension was raised upto 1000 ml with distilled water. The Hydrometer and thermometer were suspended in the measuring cylinder containing soil suspension to note the readings after specific time intervals.

The samples of razor clam were collected from mudflats during lowest tidal level when the mudflats were fully exposed. In the collection of live razor clam the salt and iron stick (more than one foot in size with one side wooden or plastic handle or holder) was used. Initially a small quantity of salt was deposited on the mud hole and iron stick was moved in the hole. Within few seconds the animal hauled out from burrow and then were captured by handpicking.

RESULTS AND DISCUSSION

The study shows seasonal pattern in the species growth, survival and dispersal are closely related. Temperature was the most important ecological factor that plays a vital role on the occurrence of this organism (Fig. 2). The range of dissolved oxygen in surrounding waters of mudflat was ranged between 6.7 to 11.7 mg/l depending on the tidal action and seasonal fluctuation. Dissolved oxygen is most important factor for the living components because the existence and health of organism is influenced by the level of oxygen. The oxygen also supports and balanced aquatic ecosystem for razor clam fishery (Fig. 3). The salinity of the study area ranged between 22 to 38 ppt at all sampling stations (Fig. 4). The other major components are magnesium, potassium and sulfate. The variation recorded is apparently due to the high tidal action and dilution during flood seasons or pollution. The recorded pH value of water ranged between 7.7 to 8.4. It was observed that pH variation has no influence on the occurrence and abundance of razor clams (Fig 5). Soil samples were collected from the depth of 2 to 3 feet through drill machine at the low tide. Results indicated no variation in the soil samples from all stations. The soil determination showed in percentage vs; silt clay 15 to 30, sandy clay 20 to 40 and fine sand 30 to 40 (Fig. 6).

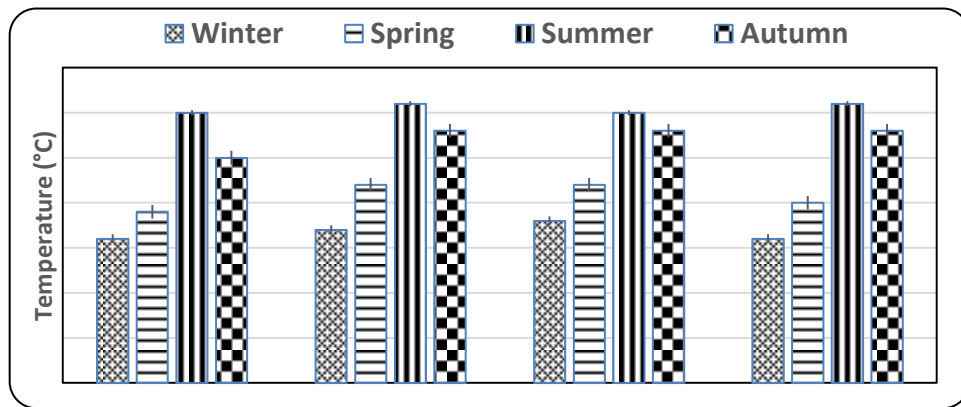


Fig. 2. Seasonal variation in temperature of creek water at mudflat of razor clam.

Moazzam, and Ahmed (1986) reported the growth and dispersal of clam species at coastal zone of Pakistan. Mahar (2018) reported the fishery status of razor clam for Pakistan. Saying that razor clam abundantly grows in sandy wet mudflats. Local peoples capture clams at least for the period of 2-3 months in one identified mudflat and then moved to the other sites for fishing.

Body of Razor Clam shell is cylindrical, thin and elongate. Dorsal and ventral margins are straight and parallel. The end of shell obliquely truncates with a distinct dorso-ventral groove close to margin. Sculpture of fine concentric lines appear during the growth stages to become mature. A single cardinal tooth in each valve is present. Anterior adductor scar almost as long as ligament. Posterior side is usually small and rounded and often close to the dorsal edge of the pallial sinus.

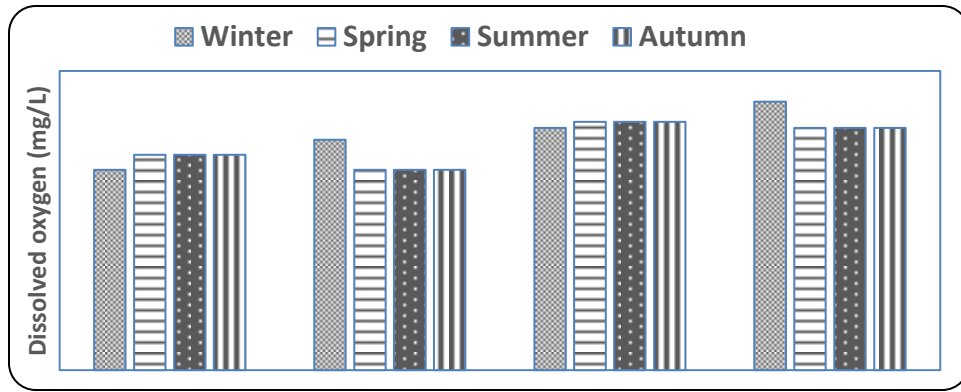


Fig. 3. Seasonal variation in dissolved oxygen of water at coastal creeks of Sindh.

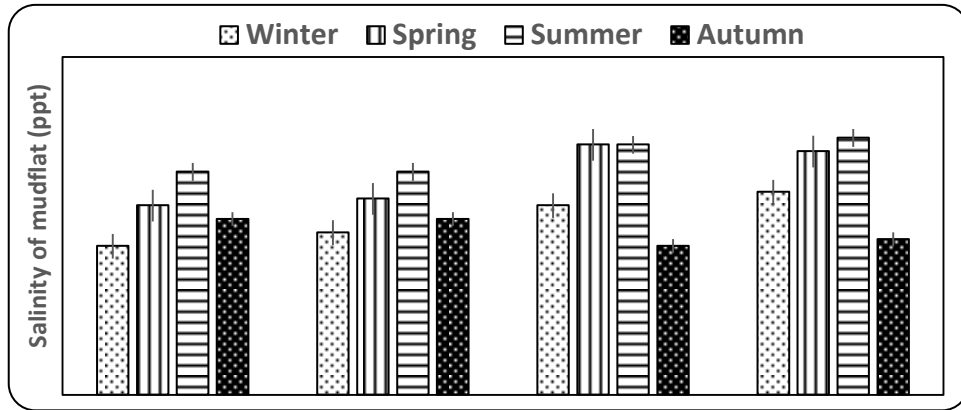


Fig. 4. Seasonal variation in Salinity of mudflat habitat of razor clam.

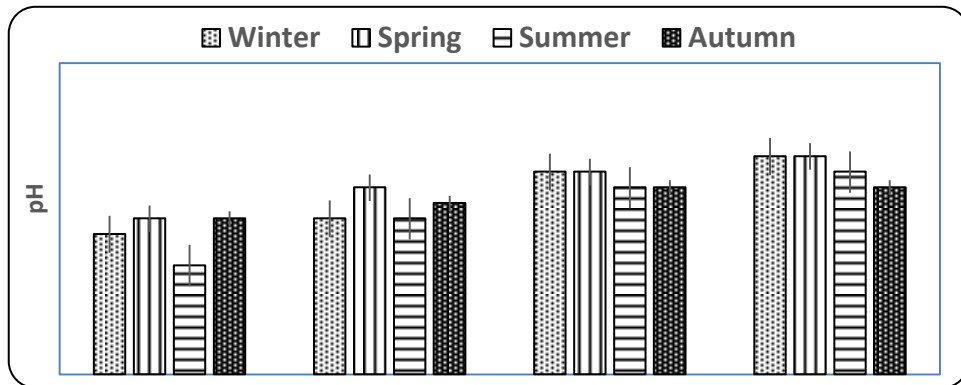


Fig. 5. Seasonal variation in pH of mudflats habitat of razor clam.

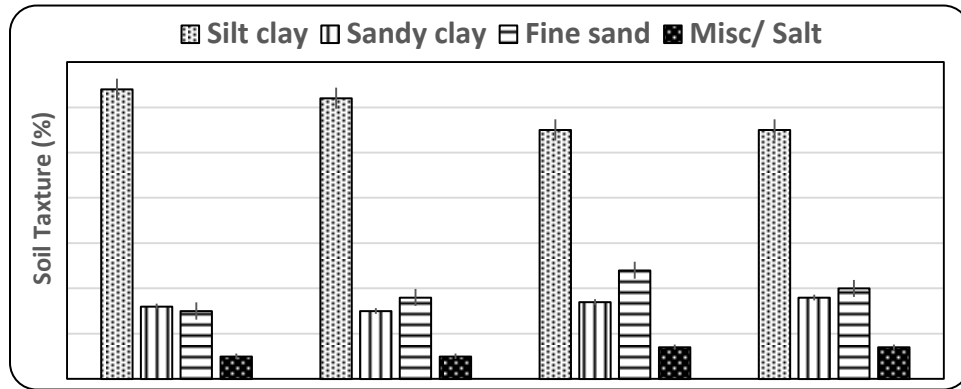


Fig. 6. Soil texture / quality of mudflats razor clam occurrence.

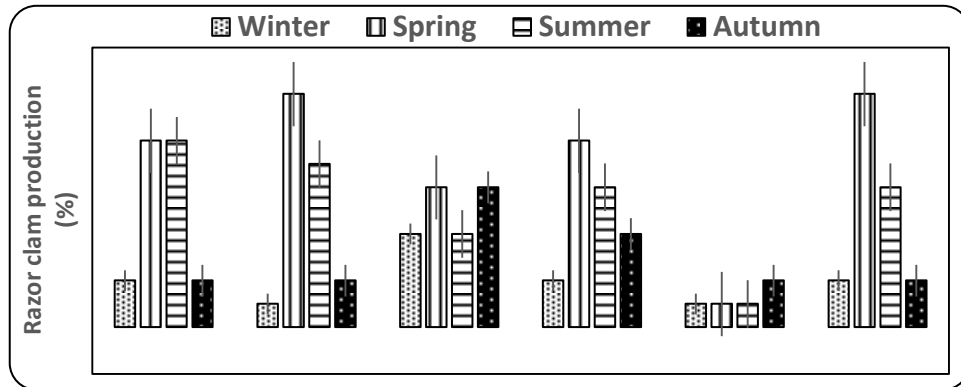


Fig. 7. Environmental impact assessment on the production of razor clam on seasonal basis.

The length reached up to 12 cm and weighs about 32 grams. Colors whitish and periostracum glossy, light olive or brown. Inner surface is yellowish. Ahmed (1986) reported the size length and weight of razor clam species from Pakistan. During the study period, the size of Razor clam was divided into three categories; immature size which was 3 to 6 cm in length, 0.2 to 1.0 cm width and weight 4 to 7 gram, while premature size was observed from 7 to 9 cm in length, 1.2 to 1.5 cm width and 8 to 13 gram in weight, subsequently mature or marketable size was 11 to 19 cm, 1.7 to 2.0 cm width and weight was recorded from 15 to 24 gram (Table 1 and Fig.7). The present results are in confirmation with the findings of Alagarswami (1966). Generally the clams are hermaphrodites and become sexually mature between the periods of three to eight months. So, they reproduced at least two times in a season. The time of reproduction & swapping is usually occurs in the month of May to June and September to October. The fertilization is external and both the sperms & eggs are released. After fertilization the individuals remain in the planktonic forms at least for the period of six to fifteen weeks,

Table 1. Size length, width and weight of *Solen dactylus* Razor clam.

Sample No.	Length (cm)	Width (cm)	Weight (g)
Immature spats			
1	3	0.2	4
2	3	0.3	4
3	4	0.5	4
4	4	0.7	5
5	6	1.0	7
Premature specimen			
1	7	1.2	8
2	7	1.3	9
3	9	1.3	10
4	9	1.4	10
5	9	1.5	13
Mature specimen			
1	11	1.7	15
2	12	1.7	18
3	15	1.7	19
4	17	1.8	22
5	19	2.0	24

then settle down in to bottom till maturity. The maturity cycle in the animal develops in barrows till the further period at twenty months. Thus, the animal attains size between 6 to 8 cm. During the reproduction period of Razor clam that is summer season the rich planktonic population plays a vital role as a primary food for parents and young ones. Determinatin of sex morphlogically is not easy. The male and female can only be differentiated by dissection. The sperms & eggs are usually taken at afternoon or evening depending upon tidal action, transparency, and temperature ranges between 27 to 29 with planktonic richness. The seasonal variation, development, reproduction and production of razor clam consist upon the suitability of the environmental factors of habitat. Present study indicates that all of the ecological factors are satisfactory which support the growth of Razor clam. The breeding and development of razor clam is influenced by harvesting mechanism that depends on harvesters i.e. the local community. The local community knows that mature production of razor clam is ready after the gap of at least 2 years. Two season spring and summer are suitable for the capture of mature clams.

A number of people including contractors, fishing communities, harvesters and laborers of Razor clam were interviewed in connection to high density population, maturity, marketable size and season of harvesting. The local people and contractors at sites of Keti Bandar and Darya Peerabad sites told that spring, summer and early winter are harvesting seasons and crop maturity periods. Winter and rainy seasons are not suitable for Razor clam fishing. In winter the animals become inactive and remain in

deep burrows and do not come-up at surface. During the rainfall the Razor clam holes get filled with fine silt thus large number of razor clam are affected and even death may occur if mudflats are exposed at the time of heavy rains. They further inform that a few months ago large quantities of Razor clam were available at Darya peer sites thus the crop was harvested. Now the harvesting labor and fishing communities moved to other sites namely Khadiwaari, Ghorewaari, Sunahrewaari and Toshawaari. It was revealed to local community of Ketī Bandar town that after harvesting ripe Razor clam the whole community shifted to another area and after 6-10 months interval, they will return again for harvesting the marketable size of Razor clam (Table 2).

Table 2. Seasonal variation in development and production of Razor clam fishery (%).

Stages	Winter	Spring	Summer	Autumn
Harvesting	10	40	40	10
Breeding	5	50	35	10
Development period	20	30	20	30
Maturation period	10	40	30	20
Rainy season	5	5	5	10
Drought / flooding	10	50	30	10

Tirmizi, and Zehra (1982) published data of marine and coastal bivalves in the illustrated guide in which they reported edible clam species. For last ten years, high quality Razor clam was harvested from mudflats of Phitti creek to Khobbar creek using very simple traditional techniques of harvesting. According to the statement of local fishing community the fishing of Razor clam usually occurs round the year except rainy seasons. During rains the mudflats and holes of Razor clam are filled with fine silt and mud therefore the community cannot dig out for the fish. During high temperatures, cold spells, rainfall, cyclones and high tide periods the Razor clam fishery is highly affected and decreases significantly. Therefore, the harvesting teams and labor of small contractors are shifted to other sites Khadiwaari, Ghorewaari, Sunahrewaari, Toshawaari. According to the statements of Razor clam harvesters, fishing labor and contractors: A trained person dig-out 1.5-3 kg of Razor clam in 1 square meter taking time of 20-40 minutes and in such a way a person can collect 10-20 kg of Razor clam in a period of 3-4 hours. One trained person dig-out/collect 1.5-3 kg of Razor clam in one square meter area in 20-40 minutes. One trained person collects 10-20 kg of Razor clam in period of 3-4 hours. One family (5-10 persons) collects 50-120 kg in 24 hours. One landing center collects 1500-2000 kg of live Razor clam and send to company at Karachi. One company export 12000-30,000 kg of live Razor clam per day (Table 3).

Table 3. Intensity of Razor clam fishing.

Harvesters	Razor clam quantity (Kg)	Time (hours)	Area in (meter sq.)	Daily / 24 hours
One trained adult (boy/girl)	5-12	3-6	5-20	1/2
One trained person (male/female)	15-50	3-7	10-40	2/3
One trained family (5-10 persons)	50-120	3-7	20-50	2/3
One landing center loading	1500-2000	-	-	-
One company may export	12,000-30,000	-	-	-

Razor clam fishery is probably suffering from anthropogenic activities including overexploitation of the natural stock as the conservation policy for this important fishery does not exist. Due to a number of factors, the Razor clam fishery is now substantially reduced due to over exploitation for last 2-3 years. The major causes of reduction in the natural stock of Razor clam fishery in creeks are the over exploitation, continuous shortage of freshwater in Indus delta eco-region, mixing of polluted water from industrial area of Karachi, reduction of mangrove plantation and mismanagement in the process of harvesting. Cahn (1951) suggested some valuable information regarding the artificial culture of clam species. It is another fact that due to lack of conservation policy by fisheries department government of Sindh, absence of substitute income generating activities for the fishermen communities and non-provision of education, health and infrastructure facilities a lot of losses are occurring in yield and natural cultivation of Razor clam. The Government departments performing different functions at the coastal area in Thatta includes Livestock & Fisheries department, Irrigation department, Forest & Wildlife department Agriculture department, Health department, Education department and District Government. The Livestock & Fisheries department promotes the fish farming activities, irrigation department looks after the embankments, link canals, and water quantity in the river and creeks. The wildlife department takes care of the wildlife and Health department takes care of the health and care of community, while education department provides basic and technical education to the fishing communities. The district government influences the overall monitoring and evaluations in the area. All these departments are working independently without consulting to each other and without considering the interests of the other departments. Activity of one department is often the problem for the other.. It is important to reconsider this arrangement under the umbrella of coastal development authority which is already established and working so that all the activities could be performed in a coherent manner.

Existing policies and legislation of management of natural resources are governed by the rules and regulations of respective government departments. Participation of communities

in planning and management of these resources is not covered under existing policies and legislation. The approach to manage above natural resources is 'top down'. Existing management is primarily through command and control system.. The involvement of local communities in planning, management and benefit sharing is totally non-existent. All the departments responsible for management are under staffed and lack capacity to develop and manage resources on scientific lines and adopt new technologies. These weaknesses in the present management systems have adversely affected the natural resources of Sindh coastal area. Study of baseline ecological and socio-economic reports of the creeks and coastal fisheries status as well as other relevant literature to identify existing gaps, specific issues, and their causes. Conduct village specific consultative group meetings to discuss and fine-tune the identified management strategies for sustainable fishing practices, identify roles, responsibilities of different stakeholders including relevant Government departments, NGOs, representative CBOs and community groups. Review existing government policies, legislation and practices related to the Razor clam fisheries resources to observe existing management practices, identified weaknesses in management and compare the same in relation to regional natural resource management practices such as, Nepal, Bangladesh and India. Consultation with government, local communities and other stakeholders may suggests a framework of best possible measures/strategies to address the identified threats and suggest appropriate legislative and policy framework to support implementation of such a management system, wherever necessary.

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