Habitat and Ecosystem Report

Terminos Lagoon

Fisheries Improvement Project Mexico Yucatan Peninsula blue crab-dipnet/pot/trap

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Final Document

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Contenido

Summary

This report includes a brief description of the bio-physical, biological and social processes in Terminos Lagoon and its tributaries, based on scientific information. As well as the results of the biological monitoring and interviews carried out by the FIP in the supply areas and the fishermen who directly supply blue crab.

Blue crab fishery is not considered among the most important fisheries, from an economic point of view in Campeche state, however it represents an important income to fishermen in Terminos Lagoon and its tributaries.

Fishers self-imposed commitments that will lead to better resource management, after talks, workshops and trainings are listed as follow:

- Return small blue crabs to the water at fishing grounds.
- Do not litter or throw plastic waste into the sea.
- Spread the word about the small actions we can take.
- Leave unintentional catches at fishing grounds.
- Return ovigerous females.

Although returning female soft blue crabs to the sea was always in the discussion, it did not become an agreement in any of the cases.

Acronyms

Acronym	Description
SAV	Submerged Aquatic Vegetation
FIP	Fisheries Improvement Project
INEGI	National Institute of Statistics and Geography
SEMARNAP	Environment, Natural Resources and Fisheries Secretariat
INE	Ecology National Institute
m	meters
psu	Practical salinity unit

Introduction

This report consists of two sections: the first contains ecosystem information on Terminos Lagoon, mostly from bibliographic sources. The second consists of the results of biological sampling, interviews, and workshops conducted with blue crab fishermen between 2023 and June 2025.

Terminos Lagoon was recognized in 1994 as a Flora and Fauna Protection Area. It maintains numerous fisheries, one of which is that of blue crab. The hydraulic management in the basin and global warming modifies the physicochemical characteristics of the water (temperature, salinity and pH) and, as a consequence, changes towards an homogenization of the habitat as salinity values have improved (Ramos-Miranda, et al., 2015) and a reduction of its depth.

This lagoon supports 117 species of fish, 69 of macro crustaceans (Raz, 2010), and 172 of mollusks (Reguero et al., 2010) among others. Of the species of fish and crustaceans registered for the Terminos Lagoon, 43 are commercially exploited (Ramos Miranda, 2000; Ramos Miranda et al., 2005a) (Ramos Miranda et al., 2015a), among them, the blue crab *Callinectes sapidus*.

Terminos lagoon besides having an ecological importance it has great social and economic relevance, as an area of intense economic development with population growth and industrial or extractive activities that have led to the modification of the ecosystem and habitats (Flores-Hernández, et al., 2021). Among them, Ciudad del Carmen population increase, the oil industry, agriculture development with the use of pesticides and fertilizers (Rendon-von Osten et al., 2005), natural phenomena as hurricanes. (Flores-Hernández, et al., 2021)

Since 2018 many blue crab fishermen in the area transferred their fishing effort to other more profitable fisheries such as fish and shrimp, modifying the supply area to obtain the same volume. Since then, the supply has changed continuously. Currently, most blue crab comes from Atasta, Sabancuy, and Isla Aguada, and occasionally from Pital. Blue Crab from Sánchez Magallanes is occasionally purchased at Atasta. Nuevo Campechito, Puerto Rico, Calax are other fishing grounds where sometimes blue crab is obtained.

Laguna de Términos

Terminos Lagoon is located in the southwestern area of the Gulf of Mexico (Campeche State, Mexico). This is one of the largest lagoons in Mexico with a surface of 1660 km2, forming part of the Tropical North-Western Atlantic´s marine ecoregion 68 (Southern Gulf of Mexico). The lagoon is very shallow with a mean depth of 3.5 m.(Villéger, et al., 2010) Terminos Lagoon is actually an estuarine ecosystem as it is strongly influenced by freshwater discharges from three streams located on its southern part (respectively, from west to east: Palizada River, Chumpan River, and Candelaria River). Throughout the years, several studies show that the lagoon presents important changes associated with an environmental modification, especially salinity.

The lagoon is delimited by Carmen Island (30 km long and 2.5 km wide)which separates it from the Gulf of Mexico and thus water exchanges with the sea take place through two inlets, one on its northeastern part (Puerto Real) and the other one on the northwestern part (Carmen)(Villéger, et al., 2010) with depth of 18 m and 14 m respectively (Romo-Ríos, 2013), receiving freshwater from three streams on its southern part: Palizada River, Chumpan River and Candelaria River (Ramos-Miranda, et al., 2005a).. The mouth of Carmen, which is 3.9 km wide, has a fluvial influence derived from the Palizada River, which causes little transparency of the water due to the terrigenous material in suspension. (Borges Souza, 2004, in Romo-Ríos, 2013).

Water circulation in the lagoon generally follows a clockwise direction (David and Kjerfve 1998), with seawater going inside the lagoon through the Puerto Real inlet, mixing with freshwater inputs near the stream mouth, with the resulting brackish water going outside the lagoon through the Carmen inlet (Villéger, et al., 2010)

Tides

The tide in Terminos Lagoon is of a mixed type (diurnal and semi-diurnal) being the diurnal components the dominant ones; the range between mean high tide and mean low tide in Isla del Carmen is 0.43 m and the average high tide is 0.40 m and -0.70 m. Spring tide and neap tide have an approximate period of 14 days (SEMARNAP-INE, 1997 in Romo-Ríos, 2013).

Sediments

Terminos Lagoon´s sediments are of biogenic and terrigenous origin, presenting spatio-temporal variations associated with the southwest-northeast circulation pattern present in the system, meteorological events, river discharges and the anthropogenic activity of the region. In a comparison of the composition and distribution of the sediments between results from 1963 and 2001-2002, it only presented significant differences in the Central Basin (Borges-Souza, 2004). The main sources of terrigenous sediments are the basins of the Chumpán and Palizada rivers (through the Usumacinta river on the Gulf of Mexico slope); the sources of carbonate sediment contribution are from the Gulf of Mexico through the Puerto Real Mouth and Mouth of Carmen, which are transported by tidal currents (Borges-Souza, 2004).

Winds

There are two dominant wind systems (Yáñez-Arancibia & Day, 1982):

a) northwest (October-March) with average speeds greater than 8 m/s, and b) north-northeast and east-southeast (March-September), with an average speed that varies between 4 and 6 m/s.

Climatic seasons

There are three climatic seasons in the area: dry, rainy and wind/winter season ("norte") seasons. The rainy season goes from June to October with a precipitation of 100 mm/month. Starting in November, with a slight decrease in precipitation, the wind/winter season goes until January. From February to May, the minimum precipitation values are recorded corresponding to the dry season (Yañez Arancibia, et al. 1982).

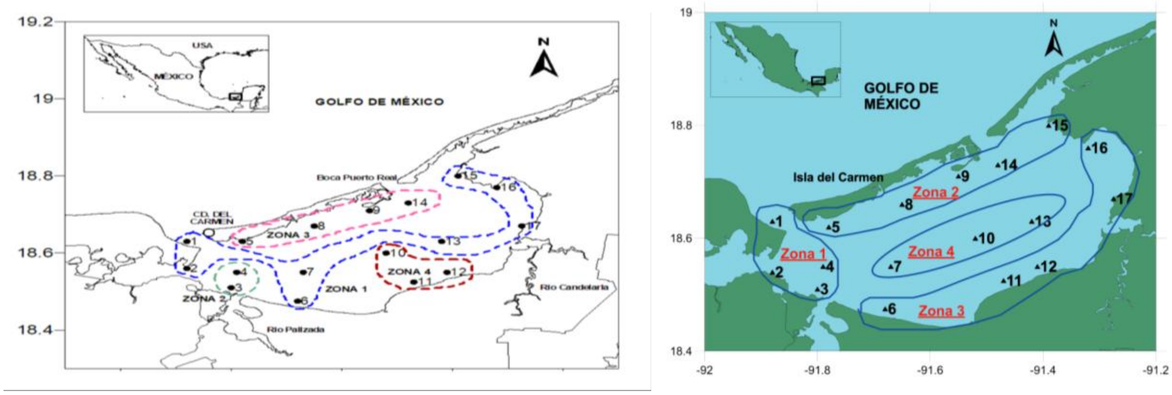
The contribution of sediment to the lagoon derives from the Palizada rivers (discharge of 238,126 m^3/s), flows into the Vapor and San Francisco lagoons through a small mouth of 7 m wide and 15 deep (Herrera Silveria et al., 2002), the Candelaria River with a discharge of 35.09 m^3/s that flows into the Panlau Lagoon and connects to the Terminos Lagoon through a 40 m wide mouth. Finally, the Chumpán and Mamantel rivers with a discharge of 1.67 m^3/s (Borges-Souza, 2004).

Water physico chemical variables

Throughout the years various studies have been carried out that describe the main physical and chemical variables of water: temperature, salinity, transparency and depth (Yáñez-Arancibia et al., 1982; Flores Hernández et al., 2001; Herrera-Silveira (2002) and Villalobos Zapata (2002), Sosa López et al. (2005)). these studies reflect the salinity and transparency gradients in the region and the fact that it is a dynamic environment that show from five to seven "habitats", whose borders are apparently environmentally changing (taken from Ramos et. Al, 2015a).

However, in the last 20 years it has been influenced by anthropic and natural impacts, which modifies the physicochemical characteristics of the water (temperature, salinity and pH) and changes in diversity species, being decisive in changes in regionalization

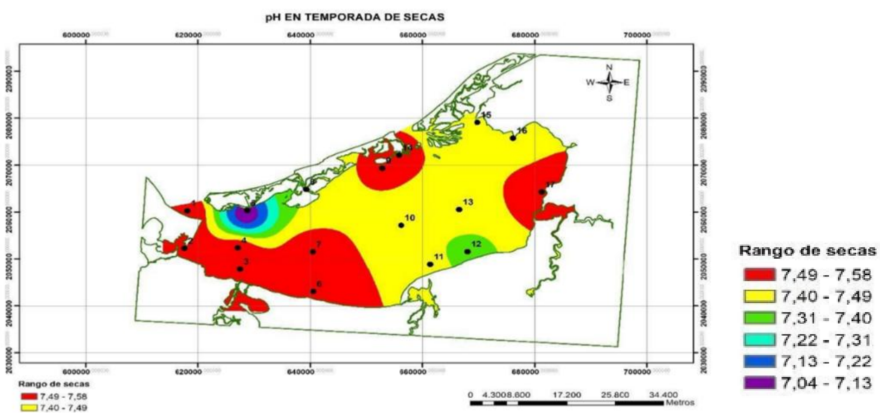
Santos, et.al. (2021) after an analysis of the spatio-temporal relationship of the physicochemical characteristics presented a new regionalization for Terminos Lagoon. Their results indicate for rainy season higher temperature values (30.59 °C), higher salinity in dry (31.78 UPS), and higher pH in the wind/winter season (7.88). In the spatial distribution, the warmest areas were shown in the Candelaria River, the most saline areas by Isla de Carmen and the highest pH ranges near Pom-Atasta. 4 new zones are represented, which are influenced by fresh water discharges and the intrusion of salt water that is carried within the site. (Fig. 1)(Santos-Santoyo, et.al.,2021).

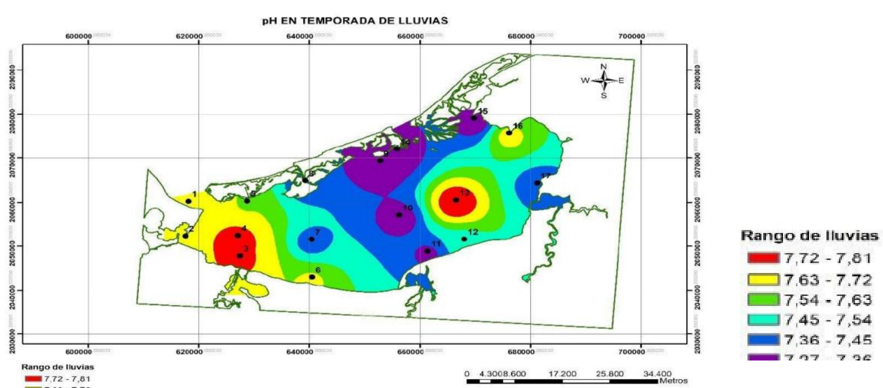


a) b)

Fig 1. Map illustrating the 4 hydrological zones defined in Terminos Lagoon after Santos, et al., 2021.(a) (Illustration from Santos, et al., 2021) and Villéger et al., 2010 (b) (illustration from Ramos, et.al., 2015a)

The pH varies from 7.04 to 8.5 depending on the climatic season (dry, rainy and northerly), with higher pH during the wind/winter season (Santos, et. al., 2021).





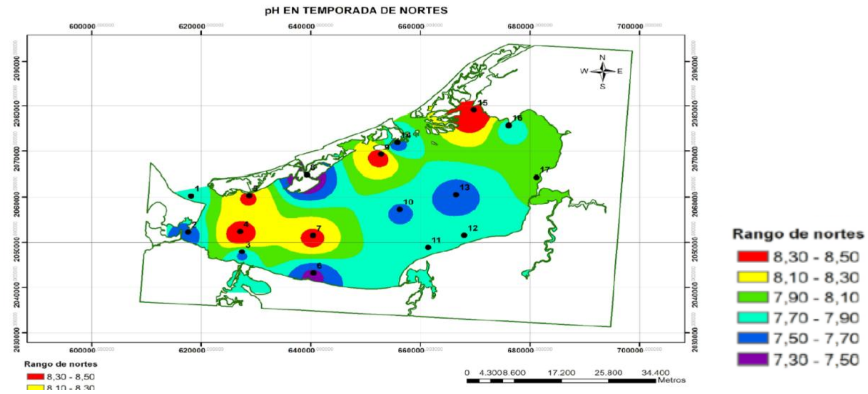
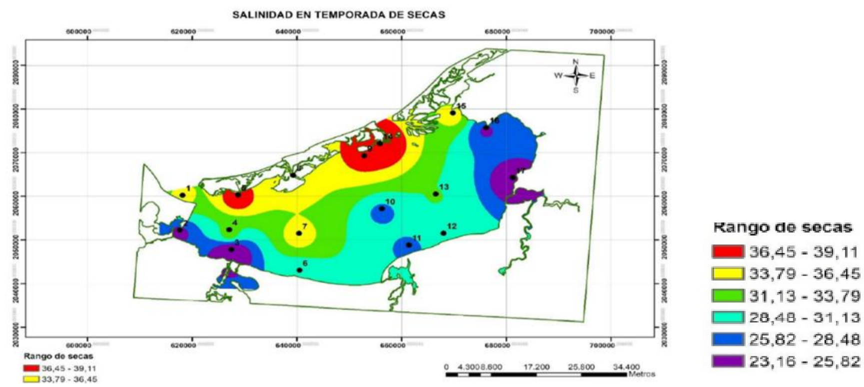
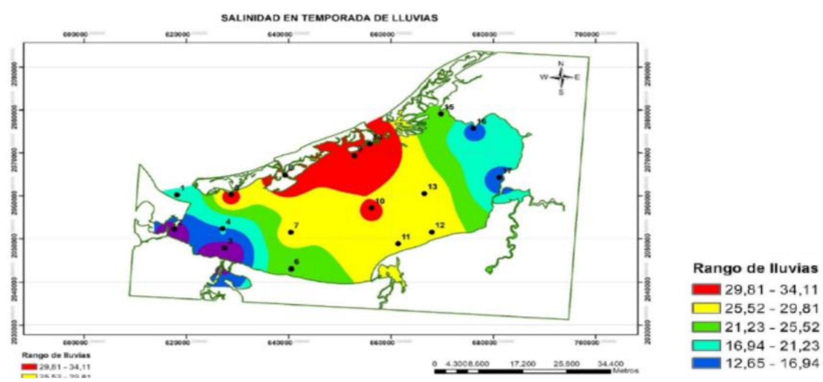


Figure 2. Spatial variability of pH by climatic seasons (dry, rainy and wind/winter) after Santos et.al., 2021. (Illustration taken from Santos, et al., 2021)





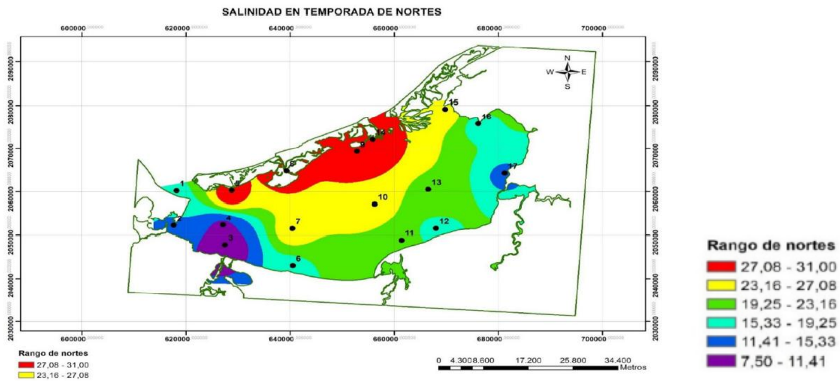


Figure 3. Spatial variability of salinity by climatic seasons (dry, rainy and wind/winter), after Santos et.al., 2021. (Illustration taken from Santos, et al., 2021)

Villeger et.al. (2010) comparisons between 1980-1981 and 1998-1999 surveys showed that the four zones established by Yañez Arancibia (1982) experienced severe modifications in their environmental conditions (Table 1). Depth and transparency were globally decreasing, particularly in Zones 1, 2, and 3, while salinity increased Villéger et al., 2010.

Table I. Environmental conditions in four zones of the Terminos Lagoon (Villeger, et al., 2010)

	Depth (m)			Sechii (m)			Bottom salinity (psu)			
Zone	1980-1981	1998-99	P	1980-1981	1998-99	P	1980-1981	1998-99	P	Substrate
1	2.8 (22 %)	2.1 (45 %)	***	0.6 (35 %)	0.5 (50 %)	*	21.3 (41 %)	23.1 (47%)	NS	muddy with fine sand and clayed silt, riverine influence
2	2.6 (32 %)	1.6 (45 %)	***	1.1 (45 %)	0.9 (49 %)	**	28.5 (25 %)	31.7 (18 %)	***	mud near mangrove swamps and sand with seagrasses and macroalgae
3	2.5 (24 %)	1.3 (35 %)	***	0.9 (38 %)	0.6 (39 %)	***	22.4 (28 %)	25.9 (22 %)	***	silt-clay sediments, mangrove swamps, riverine influences
4	3.9 (11 %)	3.9 (9 %)	NS	1.1 (36%)	1.3 (44 %)	NS	26 (25 %)	31.1 (17 %)	***	sand-silt sediments

Zone 1 is located near the mouth of Carmen, and is influenced by the discharge of freshwater from the Palizada River, whose annual discharge is> 4 X 109 m^3 year-1 and has a wide range of salinity (4 to 35 ups), presents a muddy substrate with fine sands and clays. (Villeger et al 2010)

Zone 2 covers the internal coastline of Isla del Carmen, up to the mouth of Puerto Real, this area is under marine influence with average salinities of 28.5 ups the substrate varies between muddy next to the mangrove strip *(Rhizophora mangle*) and sandy in seagrass areas (*Thalassia testudinum*). (Villeger et al 2010)

Zone 3 in the southeastern part of the lagoon, presents shallow waters close to mangrove swathes, it is influenced by the Candelaría and Chumpán rivers, with silty-clayey sediments. (Villeger et al 2010)

Zone 4 is the central part of the lagoon, with an average depth of 3.9 m, considered as a transition zone between the marine influence and the influence of fresh water, with a salinity range of 15 to 36 ups and an average of 26 ups. (Villeger et al 2010)

The behavior of the observed salinity has been interpreted by Ramos Miranda et al. (2015) as a homogenization of the habitat, pointing out that the greater intrusion of seawater and the pattern of circulation in the lagoon ecosystem, have conditioned a reduction in the wide ranges of salinity observed in the 80's. (Flores Hernández, 2021)

Submerged Aquatic Vegetation (SAV)

SAV can be found all around the Laguna de Terminos. There is evident relation between salinity gradients, freshwater inputs and the distribution of SAVs. *Calla lily*, *Eichornia crassipes*, cover large extensions toward the higher portion of the Palizada-del Este System. Rush marsh fields (*Typha sp*), as well as fields of reeds (*Phragmites*) can be found in those systems, being most abundant in the Palizada-del Este System. Other types of vegetation submerged in waters with low salinity values are *Vallisneria americana, Myriophylum exalbescens* and *Potamogeton illinoensis*. (Robadue, et.al. 2004)

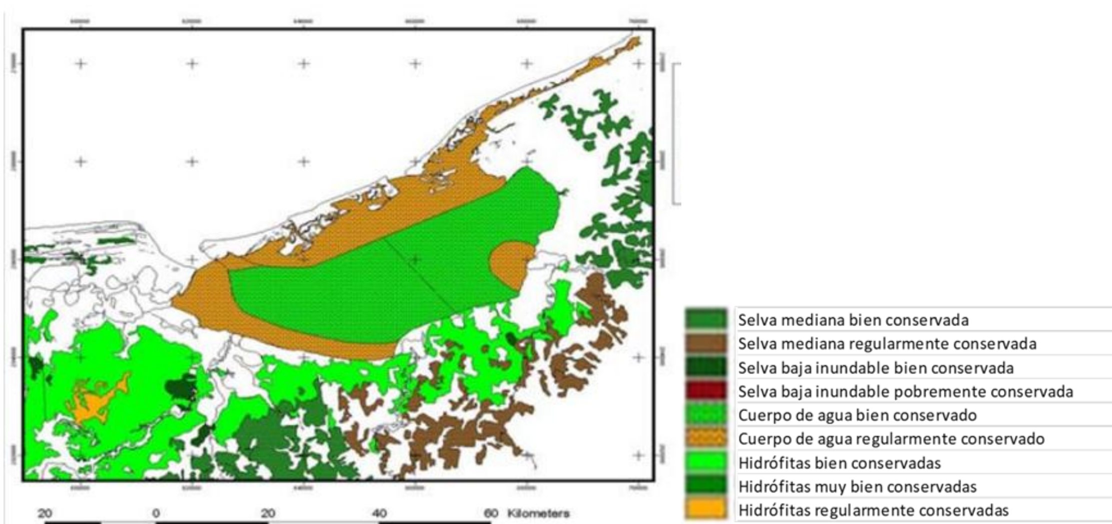


Figure 4. Map depicting distribution and location of Submerged Aquatic Vegetation and Surrounding Inundation Influenced vegetation in Laguna de Terminos Experts during Conservation Area Planning in May, 2004. (Illustration and information by Robadue, et al., 2004)

Seagrasses and macroalgae

The distribution of seagrasses and macroalgae is regulated by environmental conditions and affinity to textural groups of sediment and have been demonstrated as playing a key role in maintenance of high productivity in the region. Seagrasses are abundant in clear water (Robadue, et.al. 2004). Seagrass communities in Terminos Lagoon are dominated by *Thalassia testudinum* with two other species, *Halodule wrightii* and *Syringodium filiforme* occurring occasionally (Robadue, et.al., 2004).

The seagrasses are distributed in sandy and muddy sediments mainly on the southern coast of Isla del Carmen, through the floodtide delta at Puerto Real and along the littoral zone of the eastern and southeastern lagoon shorelines (Raz Guzman & Barba-Macías, 2000; Robadue, et.al. 2004). These regions are characterized by the highest water transparencies, salinities and percent calcium carbonates in the sediments. *Halodule* occurs on the shallowest flats while *Thalassia* extends to depths of 3 m. Greatest standing crops, leaf lengths and widths of *Thalassia* occur at depths between 1.0 and 2.0 m. Densities decrease with depth while ratios of aboveground to belowground biomass increase (Robadue, et.al., 2004). While the macroalgae are located in sites with sandy sediment such as the central part of Terminos Lagoon (Raz Guzmán & Barba-Macias, 2000). Its productivity varies between 3 and 13 gr of dry weight/m^2/ day, with the highest rates occurring during spring in the area of Mouth of Puerto Real (Moore & Wetzel, 1988).

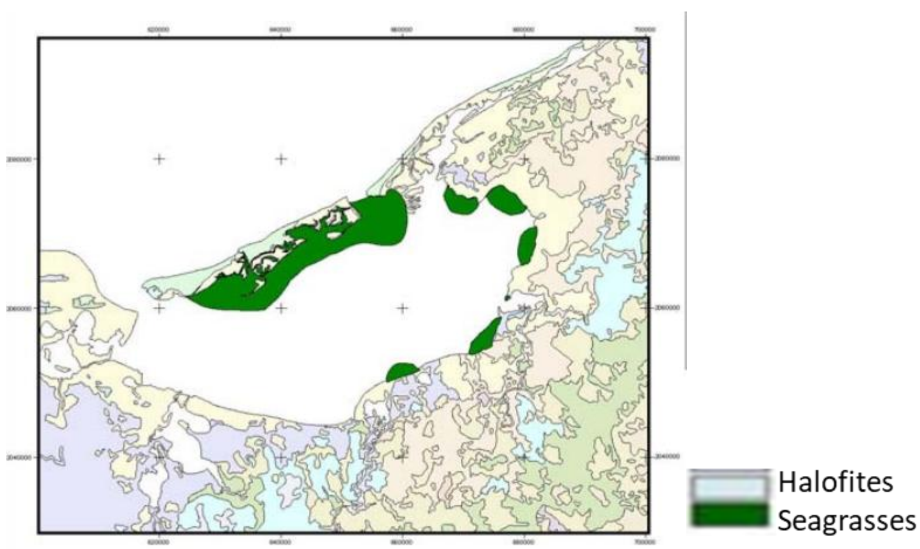


Figure 5. Map depicting distribution and location of seagrass beds in the Laguna de Terminos. Experts during Conservation Area Planning in May, 2004. (Illustration and information by Robadue, et al., 2004)

Yáñez-Arancibia et al. (1983), report a loss of *T. testudinum* of 37.5% of the coverage in the southeastern zone of Terminos Lagoon. In 1990, in the internal coastline of Isla del Carmen there was 58% coverage, while in Mouth of Puerto Real (West-East zone 2) it was 40% and in the river discharge zone (South zone 3) of 12%. By the year 2000 it was reduced to 38%, 35% and 5% respectively (Figure 6) (Herrera-Silveira et al., 2011).

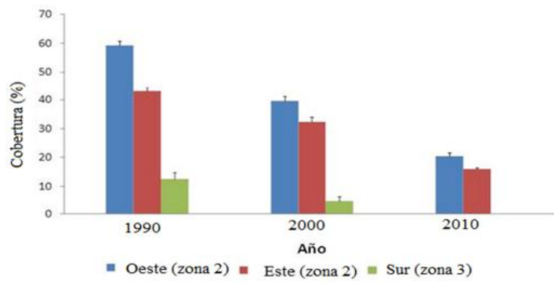


Figure 6. Distribution and coverage of *Thallasia testudinum* in Terminos Lagoon (after Herrera-Silveira, et al., 2011)

For 2010, the highest coverage percentage was in the western region (Mouth of Puerto Real) with 20%, and in the southern part of the river discharge (zone 3) there are practically no seagrasses. The loss of vegetation cover in the southeast may be related to the low salinity recorded in the area (<10 ‰), as well as low water transparency (<20%). Since this vegetation is associated with high salinity and transparency values and low levels of calcium carbonate (Yáñez-Arancibia et al., 1983; Raz-Guzman & Barba-Macías, 2000; Herrera Silveira et al., 2011 from Romo-Ríos, 2013)

Macroalgae

The distribution of macroalgae in Terminos Lagoon and the adjacent continental shelf is characterized by occurring in the sandy or sandy-silty substrate where algae such as *Cladophora vagabunda*, *Vauceheria sp*. and *Enteromorpha lingulata*. In the sediments of coarse grains, shells or shell fragments, the following species were recorded: *Gracilaria verrucosa, Spyridia filamentosa, Acanthophora spicifera, Hypnea cervicornis, H. cornuta, H. musciformis, Polysiphonia sp, Enteromorpha lingulata, Aphanocapsa littoralis*; on large oyster shells: *Chondria baileyana, Gelidium pusillum* and *Dictyota ciliolata* (Conover, 1964; from Romo-Ríos, 2013).

Ortega (2009) mentions the importance of shells as a low specific weight algal substrate, which is why it constitutes a mobile community due to the action of waves and currents. The specifically algaes that live on mangroves include *Bostrychia radicans, Caloglossa leprieurii* and *Microleus chthonoplastes*, although they are present in silts.

An important part of the vegetation is constituted by non-strict epiphytes, such as *Herposiphonia secunda, Polysiphonia ferulácea, Polysiphonia sp, Heterosiphonia crispella, Centroceras calvulatum, Enteromorpha flexuosa* sub sp *,paraxa*. Among the algae not fixed on some substrate or floating algae are *Caulerpa fastigiata var. confervoides, Chaetomorpha linum, Rhizoclonium africanum, R. kerneri* (Ortega, 2009).

Table II. Phytobenthic richnes in Terminos Lagoon. (after Ortega, 1995).

Taxa		%	Genera	Species
Algae	Rhodophyceae	56.1	30	55
	Chlorophyceae	22.4	12	22
	Phaeophyceae	6.1	5	9
	Cyanophyceae	7.1	5	7
	Xanthophyceae	1	1	1
Seagrass	Monocotyledoneae	5.1	4	5

Mangrove

Mangrove forests play an important role in the functioning of tropical coastal systems.

The four species reported for Mexico are present in Laguna de Terminos: *Rizhopora mangle* or red mangrove in the margins of rivers, lagoons and coasts, usually flooded soils, *Laguncularia racemosa* or white mangrove found in flooded soils with high levels of salinity , *Avicennia germinans* or black mangrove on sandy soils that are flooded only during part of the year or in years of maximum rainfall, *Conocarpus erecta* or buttonwood mostly on sandy and clay soils with low salinity that occasionally flooded during the rainy season (Agraz et al., 2012). In general, the forests that border the Terminos Lagoon present a 50% riparian appearance, 38.5% border, 10% basin and 1.5% scrub. This zoning is attributed to the heterogeneous environmental conditions that characterize the lagoon system, due to the fact that it receives large volumes of freshwater flows from the basin that drains into the Yucatán Peninsula, the lowlands of Tabasco and the Sierra de Chiapas. and Guatemala; as well as by the transport of terrigenic nutrients to the lagoon system, the type of soil and the anthropic activities that take place in the region of Terminos Lagoon (Agraz et al., 2012). It is relevant that the dominant appearance of the mangroves continues to be responsible for the high productivity and biodiversity that is currently recorded (Agraz et al., 2012). Various authors acknowledge that mangrove forests with riparian and border features are those that contribute the highest litter production, maintaining a rich and complex food chain characterized by high fish production (Agraz et al., 2012). On the other hand, the euryhaline water masses and the oxygen availability of the interstitial water from oxic to hypoxic prevailing in most of the Terminos Lagoon, determine the dominance of:

black mangrove (*A. germinans*) with 77.4% presenting mechanisms of excretion, exclusion, accumulation of salt and the ability to thrive in conditions of low oxygen concentration. White mangrove (*L. racemosa*) presented a dominance of 22.2%, salt excretory glands; the red mangrove (*R. mangle*), is a species with low tolerance capacity to salinity and low oxygen concentrations (Agraz et al., 2012 in Romo-Ríos, 2013).

It has been observed that during the rainy and northern seasons, the largest volume of litter is contributed to the lagoon, which fertilizes the waters favoring increases in the biomass of consumers (Barreiro-Güemes, 1999; Agraz et al., 2012) .

In Terminos Lagoon, the main origin of organic matter is autochthonous with high contributions from the mangroves in the river discharge area both in the north and rainy season, so the degree of contribution of primary producers to Sedimentary Organic Matter in Terminos Lagoon, is directly related to the extension of the vegetation present in the system (Romo-Ríos, 2013)

The organic matter from the mangrove is an important component of the export of the lagoon system to the adjacent sea in the northern season due to the system's circulation pattern. (Romo-Ríos, 2013)

Fauna

This lagoon supports 117 species of fish, 69 of macro crustaceans (Raz, 2010), and 172 of mollusks (Reguero et al., 2010) among others. Of the species of fish and crustaceans registered for the Terminos lagoon, 43 are commercially exploited (Ramos Miranda, 2000; Ramos Miranda et al., 2005a) (Ramos Miranda et al., 2015a)

Benthos

The Benthos of the lagoon reflects the circulation and sediment patterns. There is a pattern of distribution, diversity and frequency and it is possible to identify and characterize five faunal assemblages, highly correlated with salinity, substrate and primary producers in the different habitats: a) limnetic areas; b) fluvial-lagoon systems; c) inner lagoon; d) central basin and e) marine influenced areas. The species of commercial importance associated with these are: *Rangia sp*. in fluvial-lagoon sub-systems; *Crassostrea virginic*a in inner lagoons (Pantanos); *Crassostrea rhizophora*, *Melongena melongena, Pleuroploca gigantea,* and *Strombus alatus* in marine influenced areas. Numerous marine and estuarine species of decapoda occur in Terminos Lagoon. The dominant species are those that can be termed slow-swimming like *Callinectes similis, C. sapidus*, and *C. bocourti* as well as four species of penaeid shrimp, *Penaeus setiferus* which is the most abundant in the southwestern area of the lagoon (fluvial-lagoon sub-system), P. *aztecus* in the west side near Carmen Inlet, *P. duorarum* in the east side of the lagoon near Puerto Real Inlet, and *Xiphopenaeus kroyeri* in the western side and in Carmen Inlet. The studies indicate that migration into the lagoon occurs through both inlets but mainly through Carmen Inlet. (Robadue, 2004)

After an analysis of the spatio-temporal behavior of benthos biodiversity the rainy season was the one that presented the highest values in terms of **diversity and richness indices**, while at the spatial level, region adjacent to the Mouth of Atasta and Palizada river (Region 1 after Villéger et al., 2010) was the most for both indices (Irola, et al., 2021). In terms of abundance, the internal coastline of Carmen Island (region 2 after Villéger et al., 2010) was the one characterized by presenting the highest values of abundance. Therefore, regions adjacent to the Mouth of Atasta and Palizada river and the internal coastline of Carmen Island (1 and 2) represent areas of great ecological importance for the balance of biodiversity, which is why they are key areas that should be protected in Terminos Lagoon. (Irola, et al., 2021)

Ichtyc community

The Terminos lagoon supports high biodiversity and together with the adjacent Campeche probe, along with the Campeche continental shelf maintains numerous commercially important fisheries which employ thousands of people in the southern Gulf of Mexico. It was recognized in 1994 as a Flora and Fauna Protection. It has been studied since the 1960s and historical data on fish communities and their abiotic conditions have been obtained since the 1970s.

Therefore, understanding the long-term dynamics of this resource is essential in determining the present community assemblage and current magnitude species richness in order to support and maintain livelihoods in the region. (Paz-Ríos, et.al., 2021)

The spatial variations of the primary producers regulate the distribution of the fish and therefore the energy flow in terms of carbon and nitrogen of the organic matter in Terminos Lagoon and adjacent sea. The ichthyofauna present in the internal coastline of Carmen Island, Mouth of Puerto Real presents a trophic structure based on submerged vegetation (sea grasses and macroalgae) while the ichthyofauna of the fluvio-lagoon region (zone 3) presented a mangrove-based feeding source through detritus pathway. (Romo-Ríos, 2013)

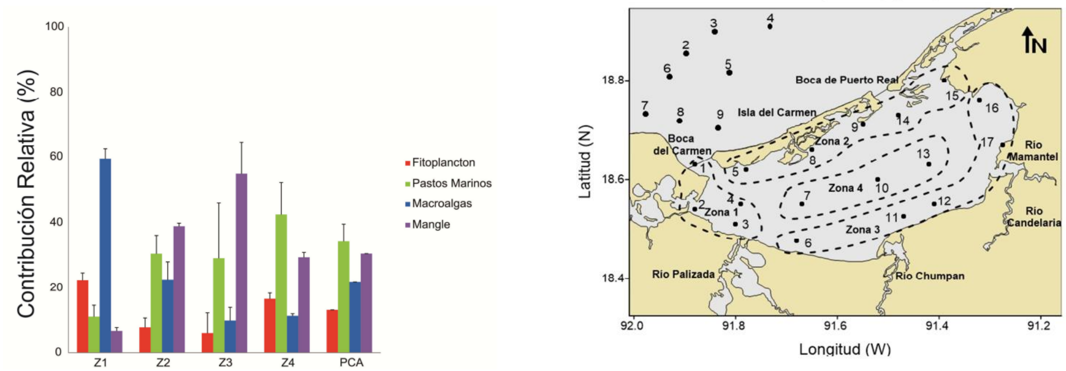


Figure 7a. Contribution of primary producers to ichtyofauna in "nortes", after Romo-Ríos, 2013. (Z1, zone 1: Z2 zone 2, Z3, zone3, Z4, zone 4 PCA adyacent continental platform) and sample stations by Romo-Ríos, 2013

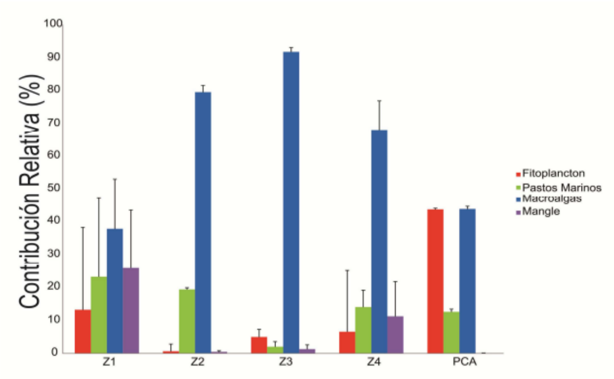


Figure 7b. Contribution of primary producers to ichtyofauna in dry season, after Romo-Ríos, 2013. (Z1, zone 1: Z2 zone 2, Z3, zone3, Z4, zone 4 PCA adyacent continental platform)

Changes in the characteristics of the water have influenced the distribution of the species (Ramos-Miranda et al., 2015a); noting that the abundance of fish communities has decreased significantly over the years (Sosa-López et al., 2006; Ramos-Miranda et al., 2015; Flores-Hernández, et al., 2021), as well as a change in the dominance of species (Ramos Miranda, et.al., 2015a), showing a greater change in its structure (biomass) than in the loss of species composition (Villegér, et al., 2010; Ramos Miranda, et.al., 2015a). The increase in salinity is probably one of the causes that can explain the variation in the abundance of the species. (Villegér, et al., 2010; Ramos Miranda, et.al., 2015a; Flores-Hernández, et al., 2021).

The behavior of the observed salinity, pointing out that the greater intrusion of seawater and the pattern of circulation in the lagoon ecosystem, have conditioned a reduction in the wide ranges of salinity observed in the 80's, and as a consequence an homogenization of the habitat (Flores-Hernández, 2021), In the northern part of the lagoon, Villeger, et al., (2010) found an increase in fish richness but a significant decrease of functional divergence and functional specialization. They explained this result by a decline of specialized species (i.e., those with particular combinations of traits), while newly occurring species are redundant with those already present. The species that decreased in abundance have functional traits linked to seagrass habitats that regressed consecutively to increasing eutrophication (Villéger et al., 2010). Thus, Terminos Lagoon becomes a habitat more frequented by species of marine origin with a trend towards a more generalist fish community, under a regime more of sharing resources than of competition (Flores-Hernández, 2021).

Birds, reptiles and mammals

The most conspicuous fauna in the Terminos Lagoon are the Birds. The records for Terminos Lagoon (Programa de Manejo de Laguna de Terminos) indicate there are 49 families with 279 species in the complex. This area is considered to harbor at least during part of the year, 33% of the migratory birds moving along the Mississippi route using this area as feeding, sheltering and nesting habitat. Many of them are endangered and the most charismatic of these is the Jabiru Stork (*Jabiru micteria*). Recent studies indicate there are only 20 individuals left in Mexico. Other wetland birds and waterfowl like *Mycteria americana* (american stork), *Anas acuta, Anas cyanoptera, Mareca americana, Aythya affinis, Amazona albífrons and Chlorocere sp* among others. In terms of other fauna, the Reptiles found in this area are essentially associated with the freshwater wetlands of "Pantanos de Centla" on the western part of the Terminos Lagoon. Here significant populations of caiman (*Caiman crocodilus*) have been reported. This area holds areas where hawksbill turtle (*Eretmochelys imbricata*) and white turtle (*Chelonia mydas*) nest in the beaches of Terminos Lagoon. Because they are threatened species they hold special concern both for the Mexican authorities as well as world conservationists. Even though they are not easily seen, there are various Mammal species that use the Terminos Lagoon. Among them are dolphins (*Tursiops truncatus*) in the inlets connecting the lagoon with the Gula of Mexico oceanic waters. Other mammal species found here are more associated with wetland habitats specifically the "Pantanos de Centla" are otters (*Lutra longicaudis*) and manatee (*Trichechus manatus*).-(Robadue, et al, 2014)

Socio-environmental characteristics

Terminos Lagoon has an important biodiversity, which has generated the idea of the possibility of intensively extracting only one of its resources until it is exhausted. In general with these productive and sociocultural practices, have prevailed in the extractive processes, demonstrating the lack of understanding of the importance of the coastal ecosystem as a reservoir of biocultural heritage. 12

In the region there are four economic, social and cultural processes that had been established linked to extensive extraction:

a) Extraction of the tree "Palo de Campeche or Palo de Tinte" (*Haematoxylum campechianum*) for 250 years, which as a colorant had great importance in the European textile industry of the second half of the 18th century. until the 19th century, which implied struggles between Spain and England for control of the exploitation zones, among them Campeche, Laguna de Terminos and Tabasco (Contreras, 1990 in Villegas, et al., 2015);
b) Later, 57 years of extensive and intensive exploitation of chicle, the chicle extraction industry generated a dynamic that marked the economy of the state of Campeche and the region of Terminos Lagoon during the first forty years of the twentieth century, although this activity has been recognized since 1890 (Vadillo, 2001 in Villegas, et al., 2015).

Both processes allowed the reshaping of the regional oligarchy closely linked to the US commercial capital, contributing during its exploitation to the deforestation of the Campeche forests (Vadillo, 2001 in Villegas, et al., 2015);

c) Subsequently, in 50 years of intensive shrimp exploitation in El Carmen, its origins, evolution and situation at the time of the transfer of the shrimp fleet from the private sector to the cooperatives in 1982, represents an outward-oriented development model, although their degree of vulnerability and dependency are lower by virtue of the provisions of the Federal Government that stimulated the growth of an industry and promoted in the locality the establishment of manufacturing institutions to process, freeze and pack shrimp, and to build and repair fishing vessels (Leriche, 2001 in Villegas, et al., 2015);
d) And until now a days, the last extractive stage with 35 years of intensive exploitation of hydrocarbons and gas with the installation of platforms in the marine area. These two social events during the twentieth century: the arrival of deep-sea fishing and later the oil activity, both are confronted with the millenary riverine culture of the region, when presenting themselves as modernization processes give rise to conflicts and tensions between the different social groups –those who inhabit and those who arrive– that are confronted by the appropriation of the territory and with it in time their spatial and sociocultural reconfiguration is observed (Villegas, 2008 in Villegas, et al., 2015).

Blue crab habitat

The life history of the blue crab involves a complex cycle of planktonic, nektonic, and benthic stages which occur throughout the estuarine-nearshore marine environment, occupying a variety of habitats depending on the requirements of each life history stage (Perry et al., 1984).

Its preferred habitat is the shallow coastal areas of the estuarine complex, with muddy and mud-clay bottoms, but they support a wide variation in environmental conditions, from fresh water (0 ‰) to hypersaline lagoons, temperature ranges ranging from 3 ºC up to 35 ºC and are also present in shallow waters or at depths of 90 m. (**https://www.ecured.cu/Jaiba_azul**)

Female blue crabs are catadromous; they migrate from hyposaline waters to higher salinity water to spawn and hatch their eggs. They are commonly seen in September-October offshore Terminos Lagoon (Fishermen from the area). The high salinity, oceanic water not only serves as habitat for the spawning female but ensures larval development, increases dispersal capabilities, decreases osmoregulatory stress, and reduces predation. Fertile eggs hatch into free swimming larvae (zoeae) which pass through a series of molts. Newly-hatched blue crab larvae normally develop through seven zoeal stages before transforming into a megalopal stage. (VanderKooy, 2013)

Megalopae return to the estuary where they metamorphose into the first crab stage. The estuarine phase is perhaps the most critical because all post-settlement growth and the major components of the reproductive cycle occur there. Male blue crabs usually remain within the estuary during their entire post-settlement life. Juvenile and adult blue crabs exhibit wide seasonal and areal distribution within estuaries.

Among the factors that limit its growth and survival are the low availability of food, the predation of other organisms, the deterioration of the habitat, since it limits its shelter and feeding and the accumulation of pollutants in the sediment given its benthic nature, while that within the physical and chemical environmental parameters of water, the one that has the greatest influence on its distribution is salinity, high temperatures and the decrease in dissolved oxygen. (VanderKooy, 2013).

Other environmental parameters that influence its abundance and distribution are rainfall and droughts due to their direct relationship with salinity and strong meteorological events due to habitat destruction.

Blue crab fishermen report that they commonly find blue crabs in seagrass areas and mud bottoms, and they have observed a decrease in seagrass areas in the lagoon.

Monitoring Program FIP Results

50 interviews were carried out with fishermen and suppliers who deliver to the FIP during 2023, using the record (Annex IV). When possible, interviews were made as

observing the by-catch on the boats. Throughout the work of the FIP we have sought to ensure that the fishermen who collaborate with us understand the need and usefulness of taking care of the habitat and the ecosystem, keeping their spaces free of garbage, recycling, releasing the organisms in the fishing ground alive and in good conditions, and promoting to comply with established regulations. Over the years, the percentage of blue crabs below the minimum legal size has remained less than 5% in total. The observed and reported bycatch have decreased, as fishers release alive organisms in the fishing ground. Catches of *Menippe mercenaria* are sometimes present (chelaes), but in lesser extent. An increase in the number of soft crab buyers has been observed in the localities. The FIP, not being able to compete with the income it generates for fishermen, is promoting the release of at least the juvenile females. The FIP have suggested to release the soft-egg-bearing females and keep the males. We have not been able to verify whether this suggestion has led to any change among the fishermen or not.

Palo Alto

Fishermen in this area, most of the year, fish in canoes propelled by wooden poles, without a motor. Their catches per day vary between 18 and 35 kilos of crab per day. They make their catches with cages that they leave working in the evening and collect in the early morning of the next day. By not requiring to pay for gasoline, its captures are economically efficient. Even so, buyers of smooth crab have been detected in their landing area. They catch their catches in shallow areas of between half a meter and one meter in muddy, grassy or sandy areas. They commonly do not bring associated catches on their boats except for the fish checkered puffer (Sphoeroides testudineus) and some crabs that they release in the mangrove and species for self-consumption.

Isla Aguada

Purchases are made through a permit holder, so it is not possible to verify the species they bring on their boats. Periodically they are given short talks about the importance of taking care of the habitat of the species they capture. These fishermen go out with motor boats, generally catching between half a meter and 3 meters deep, in seagrass or muddy-sandy areas. Since they recognize the importance of the habitat, and that they use to fish in the same area for several years (some of them for around 10 years), they usually leave non commercial or bait species in the fishing ground. When there is bad climate conditions they sometimes bring by catch back to the coast.

Atasta

In this case, purchases are also made from a permit holder. Depending on the time of year, fishermen go fishing in cayuco (during the rainy season) propelled by poles, capturing in flood-prone areas. Catches in this area are made at depths of less than one meter, and generally between 30 and 50 cm. *C. rathbunae* is frequently caught in these areas. Fishermen do not usually catch other species. In the dry season they go fishing in motor boats at depths between half a meter and 3 meters. Most of these catches are of the species *C. sapidus*, generally reporting mojarras, catfish, and seabream in their catches. Some crustaceans are released alive either in the fishing area or on the banks of the mangrove. Most of these fishermen look for seagrass beds to fish, although they comment that these have been disappearing, so they also tend to fish in muddy beds. In order to save money, some of them go out to fish with nets, which will be their bait.

Sabancuy

These fishermen deliver directly to the receiving area of the processing plant. They generally fish in very shallow areas when they cannot access other types of fishing resources. You cannot observe the accompanying fauna although they mention that they prefer to release everything that is not useful to them in the fishing site to ensure that there are crabs. They have maintained their fishing sites for many years and mention that this practice has allowed them to continue fishing.

Evidence of no or limited bycatch in the boats

Baskets without bycatch

Baskets without bycatch

Bait purchase

Baskets without bycatch

Baskets without bycatch

Baskets without bycatch




Evidence of workshops







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Fishers commitments

Through workshops, talks, and training sessions, we have sought to encourage fishing groups, cooperatives, and permit holders to establish self-imposed commitments that will lead to better resource management. These are listed below:

- Return small blue crabs to the water at fishing grounds.
- Do not litter or throw plastic waste into the sea.
- Spread the word about the small actions we can take.
- Leave unintentional catches at fishing grounds.
- Return ovigerous females

Although there returning female soft blue crabs to the sea was in the discussion, it did not become an agreement in any of the cases.

Species listed as associated in talks and workshops in 2025

The associated species listed by fishermen in 2025 using Annex V format were as follows:

Dasyatis sabina

Bagre marinus

Ariopsis felis

Synodus foetens

Prionotus scitulus

Eucinostomus argenteus

Archosargus probatocephalus

Archosargus rhomboidalis

Trichiurus lepturus

Sphoeroides testadineus

Chilomycterus schoepfii

Sphoeroides nephelus

Urobatis jamaicensi

Harengula jaguana

Ariopsis felis

Cathorops melanopus

Lutjanus plumieri

Lutjanus apodus

Chaetodipterus faber

Mujil curema

Lutjanus analis

Eucinostomus argenteus

Eugerres plumieri

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Annex 1. Systematic list of species captured in Laguna de Terminos, period 2016-2017 (taken from Irola, et al., 2021)

	Family	Species
Bivalva	Ostreidae	*Crassostrea virginica*
Gastrópoda	Cassidae	*Semicassis granulata*
	Fasciolariidae	*Triplofusus giganteus*
	Buccinidae	*Sinistrofulgur perversum*
		Fulguropsis sipirata
	Strombidae	*Strombus alatus*
Cephalopoda	Loliginidae	*Lolliguncula brevis*
	Squillidae	*Squilla empusa*
Crustacea	Peneidae	*Penaeus aztecus*
		Penaeus (Farfantepenaeus) duorarum
		Penaeus (Litopenaeus) setiferus
		Rimapenaeus similis
		Xiphopenaeus kroyeri
	Sicyoniidae	*Sicyonia brevirostris*
	Menippidae	*Menippe mercenaria*
	Portunidae	*Callinectes bocourti*
		Callinectes danae
		Callinectes rathbunae
		Callinectes sapidus
		Callinectes similis
Rayas	Rhinobatidae	*Pseudobatos lentiginosus*
	Dasyatidae	*Dasyatis sabina*
		Himantura schmardae
		Hypanus americanus
	Urotrygonidae	*Urobatis jamaicensis*
	Gymnuridae	*Gymnura micrura*
Teleosti	Clupeidae	*Dorosoma anale*
		Harengula jaguana
		Opisthonema oglinum
	Engraulidae	*Anchoa hepsetus*
		Anchoa lamprotaenia
		Anchoa mitchilli
		Cetrengraulis edentulus
	Synodontidae	*Synodus foetens*
	Ariidae	*Ariopsis felis*

		Arius melanopus
		Bagre marinus
	Batrachoididae	*Opsanus beta*
	Hemiramphidae	*Chriodorus atherinoides*
	Syngnathidae	*Hippocampus zosterae*
		Hippocampus erectus
		Syngnathus floridae
		Syngnathus louisianae
		Syngnathus scovelli
	Triglidae	*Prionotus carolinus*
		Prionotus scitulus
		Prionotus tribulus
	Serranidae	*Diplectrum formosum*
	Carangidae	*Caranx hippos*
		Chloroscombrus chrysurus
		Hemicaranx amblyrhinchus
		Selene vomer
	Lutjanidae	*Lutjanus analis*
		Lutjanus griseus
		Lutjanus synagris
	Gerreidae	*Diapterus auratus*
		Diapterus rhombeus
		Eucinostomus argenteus
		Eucinostomus gula
		Eucinostomus melanopterus
		Eugerres plumieri
		Stenotomus caprinus
	Pomadasydae	*Anisotremus virginicus*
		Conodon nobilis
		Haemulon aurolineatum
		Haemulon bonariense
		Haemulon plumieri
		Orthopristis chrysoptera
	Sparidae	*Archosargus probatocephalus*
		Archosargus rhomboidalis
		Lagodon rhomboides
	Sciaenidae	*Bairdiella chrysura*
		Bairdiella ronchus
		Corvula batabana
		Cynoscion arenarius

CeDePesca

		Cynoscion nebulosus
		Cynoscion nothus
		Menticirrhus americanus
		Menticirrhus saxtilis
		Mentcirrhus littoralis
		Micropogonias undulatus
		Stellifer lanceolatus
	Polynemidae	*Polydactylus octonemus*
	Cichlidae	*Cichlasoma urophthalmus*
	Gobiidae	*Gobioides broussonnetti*
		Gobionellus oceanicus
	Ephippidae	*Chaetodipterus faber*
	Trichiuridae	*Trichiurus lepturus*
	Bothidae	*Citharichthys spilopterus*
	Soleidae	*Achirus lineatus*
		Trinectes maculatus
	Cynoglossidae	*Symphurus civitatium*
		Symphurus plagiusa
	Monacanthidae	*Aluterus schoepfii*
		Monacanthus ciliatus
	Ostraciidae	*Stephanolepis hispidus*
	Tetraodontidae	*Acanthostracion quadricornis*
		Sphoeroides greeleyi
		Sphoeroides nephelus
		Sphoeroides parvus
		Sphoeroides spengleri
		Sphoeroides testudineus
	Diodontidae	*Chilomycterus schoepfi*

CeDePesca

Annex 2. Fish species richness in the Terminos Lagoon: An occurrence data compilation of four sampling campaigns along a multidecadal series. From Paz-Ríos, et al., 2021.

Class	Order	Family	Species	1980-1981	1998-1999	2010-2011	2016-2017
Elasmobranchii	Myliobatiformes	*Dasyatidae*	*Dasyatis hastata* (DeKay, 1842)	●			
			**Hypanus americanus* (Hildebrand & Schroeder, 1928)			●	●
			~*Hypanus sabinus* (Lesueur, 1824)	●	●	●	●
		Gymnuridae	*Gymnura micrura* (Bloch & Schneider, 1801)			●	●
		Potamotrygonidae	*Styracura schmardae* (Werner, 1904)		●		●
		Urotrygonidae	*Urobatis jamaicensis* (Cuvier, 1816)	●	●	●	●
	Rhinopristiformes	*Rhinobatidae*	*Pseudobatos lentiginosus* (Garman, 1880)			●	●
Actinopteri	Acanthuriformes	Ephippidae	*~Chaetodipterus faber (Broussonet, 1782)	●	●	●	●
		Lobotidae	*~Lobotes surinamensis (Bloch, 1790)		●		
	Anguilliformes	Muraenidae	Gymnothorax nigromarginatus (Girard, 1858)			●	
			Gymnothorax saxicola Jordan & Davis, 1891		●		
		Ophichthidae	Ophichthus gomesii (Castelnau, 1855)	●	●		
	Aulopiformes	Synodontidae	Synodus foetens (Linnaeus, 1766)	●	●	●	●
	Batrachoidiformes	Batrachoididae	~Opsanus beta (Goode & Bean, 1880)	●	●	●	●
			Porichthys porosissimus (Cuvier, 1829)	●	●	●	
	Beloniformes	Belonidae	~Strongylura notata (Poey, 1860)		●		
		Hemiramphidae	~Chriodorus atherinoides Goode & Bean, 1882	●			●
	Blenniiformes	Blenniidae	Hypleurochilus geminatus (Wood, 1825)				●
		Labrisomidae	Paraclinus fasciatus (Steindachner, 1876)				●
	Carangiformes	Achiridae	~Achirus lineatus (Linnaeus, 1758)	●	●	●	●
			~Trinectes maculatus (Bloch & Schneider, 1801)	●	●	●	●
		Bothidae	Bothus ocellatus (Agassiz, 1831)	●			
		Carangidae	*Caranx crysos (Mitchill, 1815)		●	●	
			*~Caranx hippos (Linnaeus, 1766)	●	●	●	●
			~Caranx latus Agassiz, 1831			●	
			Caranx ruber (Bloch, 1793)			●	
			*Chloroscombrus chrysurus (Linnaeus, 1766)	●	●	●	●
			Hemicaranx amblyrhynchus (Cuvier, 1833)		●	●	●
			~Oligoplites saurus (Bloch & Schneider, 1801)	●	●	●	
			*Selene setapinnis (Mitchill, 1815)		●	●	
			Selene vomer (Linnaeus, 1758)	●	●	●	●
			*Trachinotus carolinus (Linnaeus, 1766)		●		
			Trachinotus falcatus (Linnaeus, 1758)		●		
			Trachinotus goodei Jordan & Evermann, 1896		●		
		Centropomidae	*~Centropomus parallelus Poey, 1860		●	●	
			*~Centropomus poeyi Chávez, 1961		●		
			*~Centropomus undecimalis (Bloch, 1792)	●			
		Cynoglossidae	*Symphurus civitatum Ginsburg, 1951		●		●
			~Symphurus plagiusa (Linnaeus, 1766)	●	●	●	●
		Paralichthyidae	Ancylopsetta quadrocellata Gill, 1864	●		●	
			~Citharichthys spilopterus Günther, 1862	●	●	●	●
			Etropus crossotus Jordan & Gilbert, 1882	●	●	●	●
			Syacium gunteri Ginsburg, 1933			●	
		Polynemidae	Polydactylus octonemus (Girard, 1858)	●	●	●	●
		Sphyraenidae	Sphyraena barracuda (Edwards, 1771)			●	
	Cichliformes	Cichlidae	~Mayaheros urophthalmus (Günther, 1862)	●	●	●	●
	Clupeiformes	Clupeidae	*~Brevoortia gunteri Hildebrand, 1948		●		
			~Dorosoma anale Meek, 1904			●	
			~Dorosoma petenense (Günther, 1867)		●	●	
			*Harengula clupeola (Cuvier, 1829)				●
			*~Harengula jaguana Poey, 1865	●	●	●	●
			*Opisthonema oglinum (Lesueur, 1818)	●	●	●	●
			*Sardinella aurita Valenciennes, 1847		●		
		Engraulidae	~Anchoa hepsetus (Linnaeus, 1758)	●	●	●	●
			Anchoa lamprotaenia Hildebrand, 1943	●			●
			Anchoa lyolepis (Evermann & Marsh, 1900)			●	
			~Anchoa mitchilli (Valenciennes, 1848)	●	●	●	●
			Cetengraulis edentulus (Cuvier, 1829)	●	●	●	●

Class	Order	Family	Species	1980-1981	1998-1999	2010-2011	2016-2017
Actinopteri	Cyprinodontiforme	Fundulidae	~Lucania parva (Baird & Girard, 1855)				●
	Elopiformes	Elopidae	Elops saurus Linnaeus, 1766		●		
	Gobiiformes	Eleotridae	~Eleotris pisonis (Gmelin, 1789)				●
		Gobiidae	~Bathygobius soporator (Valenciennes, 1837)		●		
			~Gobionellus oceanicus (Pallas, 1770)	●	●	●	●
			Gobiosoma longipala Ginsburg, 1933				●
	Mugiliformes	Mugilidae	*~Mugil cephalus Linnaeus, 1758		●		
			*~Mugil curema Valenciennes, 1836		●	●	
	Perciformes	Scaridae	Nicholsina usta (Valenciennes, 1840)	●	●		
		Scorpaenidae	Scorpaena brasiliensis Cuvier, 1829			●	
			Scorpaena plumieri Bloch, 1789	●		●	●
		Triglidae	Prionotus beanii Goode, 1896	●			
			Prionotus carolinus (Linnaeus, 1771)	●	●	●	
			Prionotus martis Ginsburg, 1950			●	
			Prionotus punctatus (Bloch, 1793)	●		●	
			Prionotus rubio Jordan, 1886			●	●
			Prionotus scitulus Jordan & Gilbert, 1882	●	●	●	●
			Prionotus tribulus Cuvier, 1829	●		●	●
		Gerreidae	~Diapterus auratus Ranzani, 1842		●	●	●
			~Diapterus rhombeus (Cuvier, 1829)	●	●	●	●
			~Eucinostomus argenteus Baird & Girard, 1855	●	●	●	●
			~Eucinostomus gula (Quoy & Gaimard, 1824)	●	●	●	●
			~Eucinostomus melanopterus (Bleeker, 1863)	●	●		●
			*~Eugerres plumieri (Cuvier, 1830)	●	●	●	●
		Haemulidae	Anisotremus virginicus (Linnaeus, 1758)				●
			*~Conodon nobilis (Linnaeus, 1758)		●		
			Haemulon aurolineatum Cuvier, 1830		●	●	●
			*Haemulon bonariense Cuvier, 1830	●	●	●	●
			*Haemulon plumierii (Lacepède, 1801)	●	●	●	●
			*~Orthopristis chrysoptera (Linnaeus, 1766)	●	●	●	●
		Lutjanidae	*~Lutjanus analis (Cuvier, 1828)	●	●		●
			*Lutjanus apodus (Walbaum, 1792)		●		
			*~Lutjanus griseus (Linnaeus, 1758)	●	●	●	●
			*Lutjanus synagris (Linnaeus, 1758)	●	●	●	●
			*Ocyurus chrysurus (Bloch, 1791)		●		
		Sciaenidae	*~Bairdiella chrysoura (Lacepède, 1802)	●	●	●	●
			*Bairdiella ronchus (Cuvier, 1830)	●	●	●	●
			Corvula batabana (Poey, 1860)				●
			*~Cynoscion arenarius Ginsburg, 1930	●	●	●	●
			*~Cynoscion nebulosus (Cuvier, 1830)	●	●	●	●
			*Cynoscion nothus (Holbrook, 1848)	●		●	●
			*Menticirrhus americanus (Linnaeus, 1758)	●	●	●	●
			*Menticirrhus littoralis (Holbrook, 1847)				●
			Menticirrhus saxatilis (Bloch & Schneider, 1801)	●	●	●	●
			~Micropogonias furnieri (Desmarest, 1823)			●	●
			*~Micropogonias undulatus (Linnaeus, 1766)	●	●	●	●
			Odontoscion dentex (Cuvier, 1830)	●			
			~Stellifer lanceolatus (Holbrook, 1855)	●	●	●	●
		Serranidae	Diplectrum bivittatum (Valenciennes, 1828)			●	
			*Diplectrum formosum (Linnaeus, 1766)			●	●
			Epinephelus itajara (Lichtenstein, 1822)		●		
			*Mycteroperca bonaci (Poey, 1860)		●	●	
		Sparidae	*~Archosargus probatocephalus (Walbaum, 1792	●	●	●	●
			Archosargus rhomboidalis (Linnaeus, 1758)	●	●	●	●
			Calamus penna (Valenciennes, 1830)		●		
			*~Lagodon rhomboides (Linnaeus, 1766)		●	●	●
			Stenotomus caprinus Jordan & Gilbert, 1882				●

Class	Order	Family	Species	1980-1981	1998-1999	2010-2011	2016-2017
Actinopteri	Scombriformes	Stromateidae	Peprilus paru (Linnaeus, 1758)		●	●	
		Trichiuridae	*Trichiurus lepturus Linnaeus, 1758	●	●	●	●
	Siluriformes	Ariidae	*~Ariopsis felis (Linnaeus, 1766)	●	●	●	●
			*Bagre marinus (Mitchill, 1815)	●	●	●	●
			*~Cathorops melanopus (Günther, 1864)	●	●	●	●
	Syngnathiformes	Dactylopteridae	Dactylopterus volitans (Linnaeus, 1758)			●	
		Syngnathidae	Hippocampus erectus Perry, 1810	●	●	●	●
			Hippocampus zosterae Jordan & Gilbert, 1882				●
			Syngnathus floridae (Jordan & Gilbert, 1882)				●
			~Syngnathus fuscus Storer, 1839			●	
			Syngnathus louisianae Günther, 1870	●	●		●
			~Syngnathus scovelli (Evermann & Kendall, 1896)	●	●	●	●
	Tetraodontiformes	Diodontidae	Chilomycterus schoepfii (Walbaum, 1792)	●	●	●	●
		Monacanthidae	Aluterus schoepfii (Walbaum, 1792)	●		●	●
			Monacanthus ciliatus (Mitchill, 1818)		●	●	
			Stephanolepis hispida (Linnaeus, 1766)	●	●	●	●
		Ostraciidae	Acanthostracion quadricornis (Linnaeus, 1758)	●	●	●	●
		Tetraodontidae	Lagocephalus laevigatus (Linnaeus, 1766)	●	●	●	
			Sphoeroides greeleyi Gilbert, 1900	●	●	●	●
			Sphoeroides maculatus (Bloch & Schneider, 1801)			●	
			Sphoeroides marmoratus (Lowe, 1838)	●			
			Sphoeroides nephelus (Goode & Bean, 1882)	●	●	●	●
			Sphoeroides pachygaster (Müller & Troschel, 1848)			●	
			Sphoeroides parvus Shipp & Yerger, 1969			●	●
			Sphoeroides spengleri (Bloch, 1785)	●	●	●	●
			~Sphoeroides testudineus (Linnaeus, 1758)	●	●	●	●

Annex III. List of species of phytobenthos in Laguna de Términos (Ortega, 1995)

	Class	Species
Algae	Cyanophiceae	*Aphanocapsa litoralis*
		Lyngbya aestuarii
		Lyngbya confervoides
		Lyngbya majuscula
		Microcoleus chthonoplastes
		Phromidium sp
		Calothrix longifila
	Rhodophyceae	*stylonema alsidii*
		Erythrocladia irregularis
		Erythrocladia sp
		Audouinella hypneae
		Gelidium americanum
		Gelidium pusillum
		Fosliella farinosa
		Fosliella lejolisii
		Jania adhaerens
		Hypnea cervicornis
		Hypnea valentiae
		Hypnea musciformis
		Hypnea spinella
		Hypneocolax stellaris
		Agardhiella ramosissima
		Agardhiella subulata
		Eucheuma gelidium
		Eucheuma inerme
		Eucheuma isiforme
		Gracilaria caudata
		Gracilaria cervicornis
		Gracilaria curtissiae
		Gracilaria cylindrica
		Gracilaria damaecornis
		Gracilaria domingensis
		Gracilaria lemaneiformis
		Gracilaria tikvahiae
		Gracilaria venezuelensis
		Gracilaria verrucosa
		Gracilaria sp
		Gymnogongrus tenuis
		Champia parvula
		Chrysymenia sp
		Anotrichium tenue
		Callithamnion sp

	Class	Species
Algae	Rhodophyceae	*Centroceras clavulatum*
		Ceramium diaphanum
		Ceramium fastigiatum
		Ceramium flaccidum
		Spyridia filamentosa
		Wrangelia argus
		Caloglossa leprieurii
		Heterosiphonia crispella
		Acanthophora spicifera
		Bostrychia radicans
		Chondria baileyana
		Chondria sedifolia
		Chondria tenuissima
		Digenea simplex
		Herposiphonia secunda
		Laurencia gemmifera
		Laurencia papillosa
		Lophocladia trichoclados
		Polysiphonia ferulacea
		Polysiphonia sp
	Xanthophyceae	*Vaucheria sp*
	Phaeophyceae	*Ectocarpus? rhodochortonoides*
		Feldmannia elachistaeformis
		Giffordia indica
		Hincksia mitchelliae
		Hincksia sp
		Dictyota bartayresii
		Dictyota ciliolata
		Padina boergesenii
		Padina gymnospora
	Chlorophyceae	*Entocladia ventriculosum*
		Entocladia viridis
		Phaeophyla dendroides
		Enteromorpha flexuosa
		Entheromorpha lingulata
		Ulva fasciata
		Cladophoropsis membranacea
		Chaetomorpha aerea
		Chaetomorpha antenninna
		Chaetomorpha linum
		Cladophora vagabunda
		Rhizoclonium africanum
		Rhizoclonium kerneri

	Class	Species
Algae	Chlorophyceae	*Bryopsis plumosa*
		Bryopsis ramulosa
		Codium isthmocladum
		Caulerpa fastigiata
		Caulerpa mexicana
		Caulerpa prolifera v zosterifolia
		Caulerpa prolifera v zosterifolia
		Caulerpa racemosa peltata
		Caulerpa racemosa occidentales
		Caulerpa sertularioides
		Caulerpa sertularioides
		Caulerpa sertularioides longiseta
		Acetabularia crenulata
Seagrass	Monocotyledoneae	*Halophyla aschersonii*
		Halophyla decipiens
		Thalassia testudinum
		Halodule wrightii
		Syringodium filiforme

Annex IV. Example of a record of surveys conducted in 2023

REGISTRO DE DATOS DE JAIBA A PIE DE PLAYA				
PESCADOS Y MARISCOS DEL CARIBE SA DE CV Calle Aldama Manzana 90 Lote 2, Col. Banco de Piedra 24100 Sabancuy, Ciudad Del Carmen, Campeche.				
FECHA EMISION 2/JUN/2021	CLAVE: FSPR06	NO. REVISIÓN 01	FECHA REVISIÓN 2/JUNIO/2021	PÁGINA 1 DE 1

FOLIO:
COMPRADOR: Orlando Garrido
FECHA: 2/08/2023
LOCALIDAD DE DESEMBARQUE: Bahamita.
ZONA DE PESCA (UBICACIÓN MAPA): El verde.
SEMANA:
PROVEEDOR (ORGANIZACIÓN O PERMISIOANRIO): Chucho
NOMBRE EMBARCACIÓN:
PESCADOR NOMBRE COMPLETO: Jesus Rodriguez.
APODO PESCADOR: (chucho).
POTENCIA MOTOR:
Eslora (LARGO) Manga (ANCHO) Puntal (ALTURA)
AROS O NASAS #
TRAMPA # ✓
JAMO O RAQUETA #
KILOS RECIBIDOS (JAIBA Y JAIBÓN): 39 kg
KILOS JAIBA:
KILOS JAIBON:
TIPO DE CARNADA: Sardina.
HORAS DEL ARTE DE PESCA EN EL AGUA: 3 hrs.
PESO DE CARNADA (K): 6 kg

ESPECIES CAPTURADAS

C. sapidus Azul Cs ✓	*C. boccourti* Cb
C. rathbunae café, negra Cr	*C. danae* Cd
C. similis "pata seca" S	*C. ornatus* Co

INFORMACIÓN DEL HÁBITAT

Tipo de fondo: Verdoso.
Profundidad: 1 1/2 metros.
Observaciones generales durante la pesca
Descripción de como se desarrolla la pesca

Fauna asociada

Nombre común	Nombre científico	Cantidad (k)	Se descarta	Se regresa al agua	Consumo propio	Venta
Caracol.		20pz.	—	20pz.	—	—
Cangrejo		3pz.	—	3pz.	—	—
Bosh.		5pz.	2pz.	3pz.	—	—

OBSERVACIONES. Ejemplo: observacióon ocasional de otras especies como Arenareus spp. * Datum NAD27 (North American Datum 1927) o WGS84 (World Geodetic System 1984)

ELABORO: Orlando Garrido. SUPERVISO: [signature]

FSPR06 rev 01

Annex V. Example of a record of surveys and workshops conducted in 2024-2025. Images from Amador, et al. January 2007. Universidad Autónoma del Carmen. Tecnociencia.

La jaiba y su ecosistema
Política Social de Fishery Progress
FIP de Jaiba – Junio 2025

Ejercicio 1

1. ¿Cómo era la pesca de jaiba hace 15 años?

2. ¿Qué especies pescaba?

3. ¿Qué arte de pesca usaba?

4. ¿Cuántas horas hacía pescando?

5. ¿Cuántos kilos sacaba?

6. ¿De que especies y de que tamaño?

7. ¿Que otra cosa experiencia nos quieres compartir?

8. ¿Qué opinas que deberíamos hacer para proteger la pesquería y el bienestar de la comunidad?

Fig. 4. *Peces de las familias Sparidae, Sciaenidae, Ephippidae, Mugilidae, Trichiuridae, Tetraodontidae y Diodontidae asociados al manglar del suroeste de la Laguna de Términos.*

Fig. 2. *Peces de las familias Dasyatidae, Urolophidae, Elopidae, Ophicthydae, Clupeidae, Engraulidae y Ariidae asociados al manglar del suroeste de la Laguna de Términos.*

Fig. 3. *Peces de las familias Synodontidae, Centropomidae, Carangidae, Lutjanidae, Gerridae, Pomadasyidae y Sparidae asociados al manglar del suroeste de la Laguna de Términos.*