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Current status and future prospective of bluefin tuna (*Thunnus thynnus orientalis*) farming in Mexico and the West Coast of the United States

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SUMMARY – This paper provides a brief summary of the history of tuna farming in Mexico and the United States as well as future prospects for tuna farming in both countries. Production and growth performance data from a Mexican farming operation are discussed for bluefin, bigeye and yellowfin tuna. The domestic and international market situation is also reviewed. Due to the lack of quota regulations, increased national and international interests and the development of a more skilled workforce for these types of operations, both Mexico and the US are uniquely poised to expand and contribute more significantly to worldwide tuna farming production.

Key words: Tuna, husbandry, performance, markets.

RESUME – *"Situation actuelle et perspectives futures de l'élevage de thon rouge (*Thunnus thynnus orientalis*) au Mexique et sur la côte ouest des Etats-Unis". Cet article présente un bref résumé de l'historique de l'élevage du thon au Mexique et aux Etats-Unis ainsi que les perspectives futures de l'élevage de thonidés dans ces deux pays. Les données de production et de performances de croissance d'une entreprise mexicaine d'élevage sont discutées pour le thon rouge, le thon obèse et l'albacore. La situation des marchés nationaux et internationaux est également présentée. En raison du manque de réglementations concernant les quotas, des intérêts nationaux et internationaux grandissants et du développement d'une force de travail mieux formée à ces types d'opérations, le Mexique et les Etats-Unis sont fortement prédestinés à accroître et à contribuer de façon plus significative à la production du thon d'élevage à l'échelle mondiale.*

Mots-clés : *Thon, élevage, performances, marchés.*

World production of farmed northern and southern bluefin tuna is likely to exceed 20,000 tonnes (t) in 2001-2002. Mexican tuna farming operations currently represent 3% of world production. The majority of operations are located on the Pacific side of the Baja peninsula. Tuna farming began in Mexico in 1996 with marginal success and with only 1 or 2 companies in business at any one time. The limited success was largely due to weather events such as El Niño and Hurricane Nora at the time but also due to a general lack of tuna farming experience, which led to high mortalities. However, the development of many innovative techniques for both fishing and farming by Mexican operations in recent years have allowed them to emerge as significant competitors in a relatively young but growing industry.

Mexican farming operations have grown from <50 t to 600 t in the last 5 years. As of December 2001, there were 5 permitted tuna farm sites with 4 different owners. Three are for bluefin and are located in Cedros Island, Ensenada and the Coronado Islands, respectively. Two of these sites are for yellowfin and are located in Bahia Magdalena and Islas Marias. The original operators were solely Mexican owned and operated. The currently producing operations have a combination of Mexican, American, Australian and Japanese partners. As of March 2002, 6 new lease sites have been granted for bluefin, which will all be located in the Ensenada area with an allowable production of 400 t each. The original operating farms currently do not have any production restrictions. Mexico is particularly inviting for tuna farming because of its temperate weather conditions, an abundant supply of locally caught feed, proximity to major international airports in the USA, lack of various regulations and low labour costs.

Fishing bluefin in Mexican waters for farming operations have proven more difficult than in other

parts of the world. In Australia, live bait is used to readily and consistently attract southern bluefin tuna schools before they are seined. Atlantic bluefin migrate throughout the Mediterranean during their spawning season. Surface feeding and birds typically locate pre-season fish before being seined. However, the majority of catches in the Mediterranean occur in mid spawning season where the fish are typically congregated at the surface in large schools of very mixed sizes, allowing for larger and more predictable seine catches. In Mexico, many factors such as water depth, fish behaviour and unique weather conditions have contributed to inconsistent and unpredictable seasons. The majority of catches occur at night and rely mainly on the presence of bioluminescence to locate bluefin schools. Typical size at capture ranges from 15-45 kilograms, with smaller fish being caught in southern areas and larger fish to the north, and in many instances over the USA border. The catching season typically ranges from July to late August but can extend into November, depending on fishing location. Towing distances can range from 96 - >800 kilometres.

The production cycle typically ranges from 3-8 months, depending on the farm site but also depending on the size of the fish. Smaller fish that are caught in the southern areas are usually held in the cages for longer periods of time. Water temperatures typically range from 18-22ºC. Cage systems are 40-50 meters diameter, 15-20 meters deep, with holding volumes of 18,000 m^3-20,000 m^3. Fish densities can range from 2-5 kg/m^3, water currents from <1-2 knots depending on the farm site. Fish are fed both fresh and frozen sardines. Some sites also feed mackerel and squid. Weight gain can range from 30-90% of initial weight, depending on the farm site and the use of various husbandry techniques. Fish are harvested from December-April/May using the Australian method.

There are a variety of concerns particular to Mexico. Although seldom referred to or discussed is the issue of predators, in particular, sea lions. Many areas along the coastline of Mexico and its associated islands support large colonies of sea lions. They are attracted to the farms for both the tuna in the cages but also by excess feed that falls through the cages or that is discarded. Many of the farms do not use predator nets on their cage systems but instead use fences around the perimeter of the cages to prevent the sea lions from hauling out on the cages and from jumping in the cages. Some farms use electric fences around the cage surface perimeter. Although these are effective measures, significant predator effects continue to be a problem. Stress and poor growth performance are common in most of the farms. Fresh or healing wounds from the nails of the flippers or from the mouths of the sea lions are often present on the flanks and underside of the fish in at least 1/3 but sometimes up to 1/2 of the fish being harvested. Although many fish survive these wounds, their value is significantly decreased in the marketplace. Additionally, many mortalities that occur from these sea lion attacks are not accounted for or go un-noticed. The use of predator nets would greatly improve this situation. There is also a rumour from the Japanese marketplace that the flesh of the Mexican fish has a "bait smell" and is often unattractive to buyers and consumers. It is currently believed that this is caused by feeding the fish only one type of feed. The cause is debatable at this point.

As per usual with other countries farming tuna, the primary market is Japan. However, Mexico as well as the US are beginning to experience the advantages of the rapidly expanding US market for sashimi products. This is of particular importance to Mexico because of the typical small size of their farmed tuna. The smaller tuna simply cannot compete with the larger tunas farmed in other countries. As of February 2002, average prices for Mexican tuna on the Japanese market ranged from 3300-3500 ¥/kg (25-27 $/kg). Larger fish from other countries routinely average at least 4500 ¥/kg (34 $/kg). Many smaller fish go unsold on the auction floor and are typically distributed to other Japanese customers at average prices of 1500-1800 ¥/kg (11-13 $/kg). When all costs are taken into account it can be predicted that at some point in the future, marketing these small fish in Japan may become cost prohibitive. At this point, only the best quality fish go to Japan. Poor quality and predator-affected fish are sold in the US. In the future, it is predicted that a larger percentage of farmed tuna from Mexico as well as the US will be marketed in the US. As the market continues to develop and mature in the US, higher quality fish will stay in the US ultimately presenting a significant savings on the final price by just eliminating shipping and import taxes. However, because Mexico and the West coast of the US are in close proximity to major international airports and routine flights to Japan, and in order to remain competitive in the global marketplace, a percentage of fish will always target the Japanese market.

Of particular interest is the fact that other, commercially valuable tuna species such as bigeye (*T. obesus*) and yellowfin (*T. albacares*) are common inhabitants of Mexican, southern California and Hawaiian waters. These species are beginning to emerge as a valuable alternative to bluefin in the

marketplace. Efforts to farm bigeye are already underway in Spain, Chile and Hawaii. Yellowfin are successfully being farmed in Mexico. During the tuna season of 1998, the farm located in Cedros Island, Mexico, had the opportunity to rear bluefin, bigeye and yellowfin in the same cage system. This was the first time that bigeye were ever farmed and provided a unique opportunity to compare the growth performance, behaviour, husbandry requirements and post-harvest flesh quality for all three species. Table 1 provides a summary of various growth performance characteristics of each species during the study.

Table 1. Growth performance of bluefin, bigeye and yellowfin tuna reared in the same cage system-data from Atunera Nair, Cedros Island, Mexico†

Species	Start weight (kg)	Final weight (kg)	FCR	SGR (% bw/d)	Cond. Fact.
Bluefin	45	70	7:1	6	2.2
Bigeye	25-30	45	9:1	5	2.3
Yellowfin	20-25	35	10:1††	45	2.1

†Production cycle = 2.5 months; FCR's = wet weights; water temp. = 18-22ºC.
††Yellowfin would most likely perform better if in warmer temps.

There were a variety of differences between all species with regards to behaviour, parasite and disease susceptibility, and post harvest flesh quality. The details of these differences will not be discussed in this paper, as they are the subjects of another publication that is currently in progress. However, this study demonstrated that bigeye and yellowfin tuna show promise as alternative species for tuna aquaculture and may serve as surrogate species for hatchery culture of commercially valuable tunas.

Captive bluefin tuna research began on the East coast of the United States in 1989 at the New England Aquarium in Boston, Massachusetts. This research focused on basic biology, physiology, reproductive biology, early life history and the development of many handling and other husbandry techniques for captive tunas. Tuna were reared in closed, filtered seawater systems. Over 7 years of study, collection, transport, handling, anaesthesia, blood sampling, ultrasound, pathology, wild larval and juvenile collection techniques and methods were developed for bluefin. This study culminated in the first-ever permitted open ocean sea cage for tuna culture in the US in 1996. The cage was located 24 miles offshore and was primarily focused on demonstrating the feasibility of tuna aquaculture to government, scientists, fishermen and other interested parties. At that time and until this day, tuna aquaculture was too risky for east coast fishermen to undertake. This is primarily because of strict quotas and regulations for bluefin tuna that virtually make it un-economical to farm on the East coast of the US.

As of February 2002, there is still no tuna aquaculture in the US. Development has been hampered primarily by coastal user conflicts and stringent regulatory limitations. However, interest and initiatives are currently in progress for developing tuna farming operations off the West coast of the United States, particularly in Southern California but also off the coast of Hawaii. The advent of several new offshore aquaculture projects in the US coupled with strong governmental initiatives are providing the groundwork necessary to initiate tuna and other aquaculture operations in the US. Southern Californian and Mexican waters share many of the same characteristics that lend themselves as prime conditions for tuna farming as well as having the three most valuable tunas as common inhabitants. Due to the lack of quota regulations on the west coast, increased national and international interests and the development of a more skilled workforce for these types of operations, both Mexico and the US are uniquely poised to expand and contribute more significantly to worldwide tuna farming production.

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