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UNDERWATER WORLD

The American Oyster

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Fisheries and Oceans
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Canada

THE AMERICAN OYSTER

Oysters are among the few animals that people of the world still eat alive and raw. They have a long history of nourishing the human race.

When the first white settlers arrived on the shores of North America, one of the most impressive indications they had of the richness of the new land was the abundance, large size, and excellence of the oysters. Friendly Indians reportedly brought oysters along with wild turkeys to the first Thanksgiving. They taught the settlers how to tong the bivalves with leather, and how to dry them for winter food.

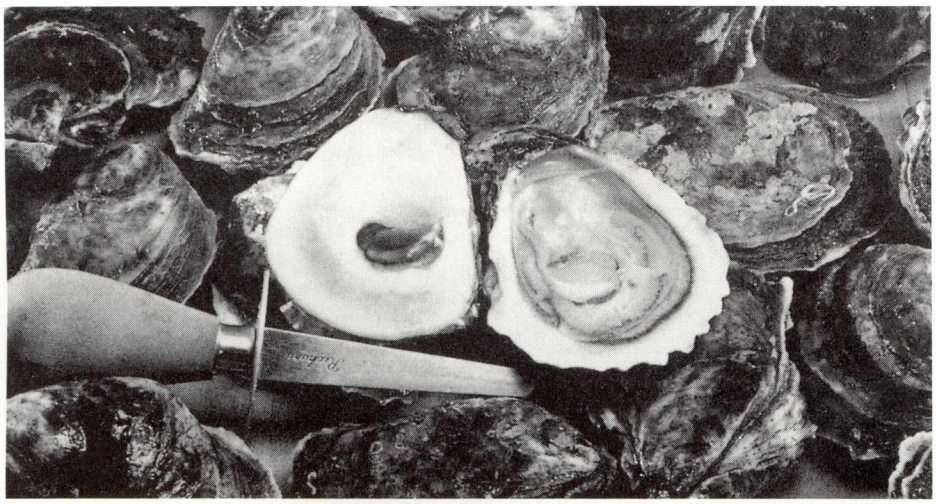
On the eastern side of the Atlantic, oysters have been a prized food since the pre-Christian era. The ancient Romans served large quantities at their banquets, learned to cultivate them, and even made a monetary unit, the denarius, equal in value to one oyster.

Oysters are sea animals that lack a backbone. They are scientifically classed as molluscs, a word from the Latin meaning soft. Protecting their soft bodies is a hard shell made up of two valves which are joined by a hinge and held together by a strong muscle.

Except in the earliest stage of their development, oysters lack power of locomotion. They are found lying motionless on the floor of brackish bays, coves and estuaries, usually attached to rocks or other hard, submerged objects, sometimes in great clusters.

Many different species of oysters occur in the inshore waters of the world's temperate and also tropical seas. The oyster native to the North American Atlantic coast is *Crassostrea virginica,* commonly known as the American oyster, the Atlantic oyster, and the Eastern oyster. It is a hardy species able to live in waters with considerable variation in salinity and temperature.

A well formed oyster shell indicates growth as separate oysters on a firm bottom and a high market grade.



Where Found

American oysters range from the West Indies and the Gulf of Mexico north to the Gulf of St. Lawrence. They are found in greatest numbers in Chesapeake Bay and along the coast of the Gulf of Mexico. Since Canadian waters are their northern outpost, the Canadian percentage of the total North American harvest is very small.

In Canada, oyster areas are restricted to the warm, shallow bays and estuaries of the southwestern Gulf of St. Lawrence and the coves of Cape Breton's Bras d'Or Lakes. Water temperatures in other coastal areas are generally too cold for their reproduction and suitable growth. They will tolerate a temperature range of -2°C to 32°C *(28°F to 90°F).*

The highest grade oysters come from areas where the bottom is firm and non-shifting. Their preferred range of water salinity probably lies between 2 and 2.7 per cent. Bays into which rivers flow, and river estuaries into which salty tides ebb and flow, meet their salinity requirement.

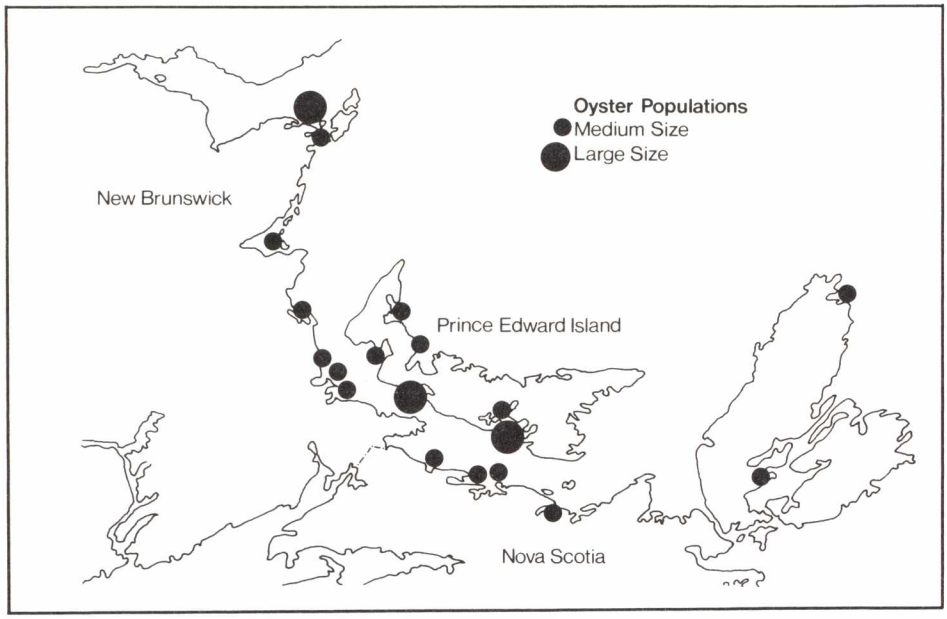
Prince Edward Island is the leading oyster-producing province followed by New Brunswick. The beds of Prince Edward Island's Malpeque Bay and Summerside Harbour, combined with those of Caraquet Bay in northern New Brunswick, account for about two-thirds of Canada's total east coast oyster harvest. Other important oyster growing areas include the bays and inlets of the Bras d'Or Lakes, New Brunswick's Miramichi Bay, and Prince Edward Island's Hillsborough and West Rivers.

A Closeup

Generally speaking, the shell of the American oyster is thick and has a rough, sculptured appearance. Its colour varies but is mainly a mixture of brown, gray, green, and white shades. The inside is a dull white and smooth to the touch, except for the prominent dark scar of the adductor muscle.

The two valves of the oyster differ in shape. The lower is cupped to accommodate the body, while the upper is flat and acts like a lid. Together they make an air and water-tight seal. A large adductor muscle, attached to both shells at a point slightly off centre, controls their opening and closing.

While the power of the adductor muscle varies with the size and condition of the oyster, it takes a pull of over 9 kg *(20 lb)* suddenly applied, to open the shell of a 7.5 to 10 cm *(3 to 4-inch)* American oyster in good condition. Once opened, the muscle may be severed and the upper shell removed to reveal the soft, headless body of the oyster in the hollow of the lower shell.



Principal oyster-producing areas of the Maritime Provinces.

The body is made up of the organs of digestion, respiration and reproduction. Enveloping it is a sheet of tissue called the mantle, which is flat and featureless except for its free borders which are thickened and exhibit three parallel folds or ridges. Each ridge has a particular function.

The ridge nearest the shell margin contains glands which secrete calcareous material to build and repair the shell. In the centre ridge are two rows of fine, dark tentacles or feelers which are extremely sensitive. Any disturbing change in the water — mechanical, chemical, or related to the amount of light, such as a passing shadow — stimulates the nerves of the mantle and causes the adductor muscle to close the shells. The inner ridge, the largest of the three, is muscular and mobile. It controls the flow of water in and out of the oyster.

Under normal conditions, the outside of the mantle adheres slightly to the shell. The parts of it not attached to underlying organs enclose a large space known as the mantle cavity, which is normally filled with sea water. As the shell closes, surplus water is ejected and what remains keeps the organs constantly bathed. As long as the oyster keeps its shells closed and retains its shell liquor, it is able to stave off predators and also survive long periods of exposure to unfavourable water conditions and to air at low tide.

Other organs become visible when the covering half of the mantle is removed. At the hinge end are the labial palps or lips surrounding the mouth; below are four porous, finely ridged, crescent-shaped gills, commonly called the beard. The gills function both as a respiratory and a food-collecting organ. Covering them are tiny, lashing hairs which create an incoming current of water from which food particles are filtered and oxygen absorbed.

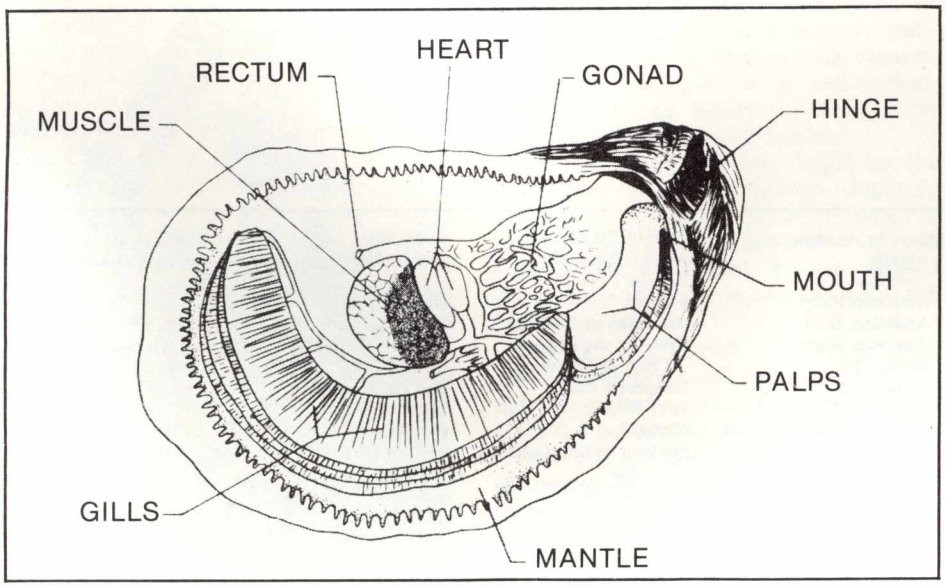
Oysters breathe much like fish, using both gills and mantle. The mantle is lined with many small, thin-walled blood vessels which extract oxygen from the water and expel carbon dioxide. A small, three-chambered heart, lying under the adductor muscle, pumps colorless blood, with its supply of oxygen, to all parts of the body. At the same time a pair of kidneys located on the underside of the muscle purify the blood of any waste products it has collected.

Incoming food is sorted by the lips and accepted morsels pass down a narrow throat into a pouch-shaped stomach surrounded by a digestive gland. Waste passes through a long, coiled intestine to be emptied by the rectum into an exhalant chamber.

There is no way of telling male oysters from females by examining their shells. While oysters have separate sexes, they may change sex one or more times during their life span. The gonads — organs responsible for producing both eggs and sperm — surround the digestive organs and are made up of sex cells, branching tubules and connective tissue.

During the summer spawning period, the tubes are filled with eggs or sperm and at this time, the so-called spawn veins may be seen on the surface of the body. When spawning is completed, an oyster is almost translucent. Gradually the space which was occupied by the eggs or sperm becomes filled with animal starch or glycogen, giving the body a smooth, creamy-white surface. Reconditioning or fattening, as this is called,

Main features of the anatomy of the oyster seen lying in its cupped shell with flat shell and covering half of the mantle removed.



Spat oysters after 5 month's growth on collector.

takes one-and-a-half to two-and-a-half months, depending on water and food conditions.

Reproduction and Early Development

The separate sexes of the American oyster ripen in early summer. When the water warms above a minimum temperature of 20°C *(68°F)*, they release eggs and sperm into the water. The spawn is not released all at once but at intervals over a period of four to six weeks. During the spawning season, a single female, by clapping her shells gently, will puff out many millions of buoyant eggs and a male will release an even greater number of sperm.

Fertilization takes place in the open water and cell division begins. The fertilized egg develops into a microscopic larva. Within 24 hours it forms a shell and develops a swimming and feeding organ consisting of a disc covered with vibrating hairs which can be thrust out and withdrawn at will, allowing free movement.

For about three weeks, the little larva swims and drifts in the tidal currents and may travel far from the spawning area. It feeds on microscopic plants of the plankton community of which it is a part. The mortality rate is very high and only a small fraction of 1 percent of the young larvae reaches the next stage of development.

When its length reaches about 300 microns, or the size of a grain of pepper, each larva extends a probing foot and seeks a place of attachment. Once it finds a suitable, clean, hard surface, the foot gland ejects a tiny pool of cement-like adhesive. The little oyster then turns on its left side, cements itself to the object, and remains immobile for the rest of its life. Henceforth, it can feed only on what food the water brings and is unable to escape overcrowding or flee from enemies.

Material put out for oysters to attach to is called *cultch*. The process of becoming cemented to the cultch is termed *setting* or *spatting*, and the young oyster after setting, *seed* or *spat*. Oyster larvae will attach themselves to many types of cultch but seem to prefer mollusc shells and materials which contain chalky substances.

Growth

Oysters grow by feeding on plankton — microscopic plants and animals present in the water. When water conditions are favorable, oysters feed almost continuously. The warmer the water, the more active the feeding, up to about 26°C *(79°F)*. A 10-cm *(4-inch)* long oyster can filter or pump water at a rate of about 9 to 13 L *(2 to 3 gal)* an hour.

When the water chills to around 4°C *(40°F)*, feeding ceases. The oysters stop filtering and seldom open their shells. However, unlike hibernating bears and other animals which live on stored fat, they show very little weight loss after the winter's sleep.

In the Maritimes, the American oyster's growth period is from May to late November with a recess in July for spawning. It takes a Gulf of St. Lawrence oyster from four to seven years to reach the legal market length of 76 mm *(3 inches)* while oysters grown in the warm waters of the Gulf of Mexico may take only two years to reach the same size. However, it is noteworthy that Canadian, slow-grown oysters tend to be of excellent quality.

Oyster growth continues throughout life, but slows with age. Some oysters have attained a length of 38 cm *(15 inches)* and have weighed over 1.35 kg *(3 lb)*. Shell characteristics indicate that some found in the Bras d'Or lakes have lived for more than 100 years.

The shape and outer appearance of an oyster's shell reflect the conditions under which it was grown. Crowding produces shell distortions. On muddy bottoms and on overcrowded reefs, oysters assume a vertical position and the shells grow long and narrow. On hard, clean bottoms, where there is no overcrowding, the shells grow round, strong, and are deeply cupped, producing oysters of first-rate quality.

Enemies and Hazards

Maritime oysters — both juvenile and adult — are preyed upon by rock crabs and starfish, and their shell is invaded by boring sponges and mud worms. The eggs and larvae are also consumed by many of the larger animals feeding on the plankton community, including their own parents.

Adverse environmental conditions such as freshets or sudden overflowings of streams, prolonged exposure to freezing temperatures at low tide, heavy silt or marine plant growth (which can smother oysters), as well as many types of industrial and domestic pollution, can all result in high oyster mortality.

Micro-organisms may also prove to be deadly enemies, such as the one causing Malpeque disease, a serious infection which devastated oyster stocks in Prince Edward Island between 1915 and 1940, and in New Brunswick and mainland Nova Scotia between 1954 and 1957. Current oyster populations in the Maritimes, outside Cape Breton, were spawned from oysters which developed resistance to the disease through natural selection.

In addition to life forms that prey on oysters, there are those which compete with them for available space and food, causing a reduction in their numbers and impairment of their quality. Mussels, for example, are their chief competitor in Maritime waters.

The Fishery

In the Maritimes, American oysters are harvested both from natural beds and from leased areas. Natural beds, not under lease, are a common property resource and anyone who purchases a licence is allowed to fish them. It has been estimated that there is a total of 6 200 hectares *(15 500 acres)* of good oyster bottom in the Maritimes, of which 624 hectares *(1 560 acres)* are natural beds open for public fishing, 3 700 hectares *(9 250 acres)* are privately leased areas, and 1 876 hectares *(4 690 acres)* are unused.

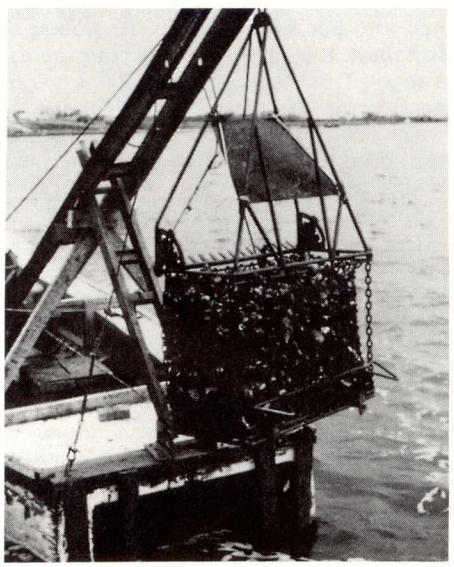
In Canada, the Department of Fisheries and Oceans manages and regulates American oyster harvesting. A rather complicated set of regulations governs oyster fishing seasons. Seasons differ for public and leased ground but, in effect, oysters are fished from August 15 to May 1, the principal harvest being taken in autumn.

Harvesting methods include the use of rakes, tongs and dredges. Handpicking is also practised at low tide in shallow waters.

Raking is done by hand on sloping bottoms reaching depths up to 7.6 m *(25 ft)*.

Tonging oysters.

Oyster drag or dredge.



The rakes have long handles and long, slightly curved teeth. Sometimes a shallow bag of wire netting is attached to the back of the head.

Tongs are also hand operated. They consist of two long-handled rakes hinged about one-third of the distance up from the heads and may have a basket of wire netting on the back of one or both heads. They are used on level bottoms in depths up to 5.4 m *(18 ft)*.

The dredge, also called the drag, can be used to fish for oysters at greater depths. It was developed to reduce costs in large-scale harvesting operations and might be likened to a large rake-head backed with a bag and attached to a strong rope in place of a handle. It is towed over the bottom by a powered boat and hoisted either by hand or by a mechanical or motor-driven device. For conservation reasons, rakes and tongs are the only gear permitted on public grounds.

After harvesting, oysters are culled. Undersized oysters and old shells are returned to the beds. Predators such as starfish and rock crabs, taken incidentally, are destroyed. Cleaning, grading, packing and shipping complete the operation.

Farming

Oysters were likely the first sea animal to be transported from one area to another and cultivated as food. The ancient world, while knowing little about the reproduction of oysters, knew much about the conditions necessary for their growth. Pliny the Elder, a noted Roman naturalist of the first century, has left an account of artificial oyster beds established in Lake Lucrinus near Naples by a Sergius Orata about 95 B.C.

Orata's methods consisted of preparing the grounds by removing other forms of marine life, planting seed oysters, cultivating the oysters by keeping them separated in order to grow to a well-formed, mature size, and finally harvesting them when they were ready for market.

Modern oyster farming, based on the knowledge of oyster biology, basically follows the Roman procedure. It began in eastern Canada in the early 1900s and has since been encouraged by the federal Department of Fisheries and Oceans which leases growing areas.

Leased areas consist of subtidal land, devoid of natural beds, yet considered suitable for oyster culture. They vary in size from 0.4 hectares to 40 hectares *(1 to 100 acres)*. The lessee has property rights over the oysters on his lease and is required to cultivate the lease as a commercial venture under penalty of forfeiture if planting and production requirements are not met.

Up to one-half of the Canadian Atlantic oyster crop currently marketed is raised for some period of time on the leases and this percentage is expected to increase.

To start a farm, the lessee may catch seed oysters on cultch placed in certain reserve areas of the public grounds. He may purchase seed oysters from a supplier, if one can be found. Or, he may obtain a permit from the federal government entitling him to gather wild oysters from the public grounds and contaminated areas for relay to his lease. Oysters from contaminated areas, relayed to clean water, cleanse themselves in a few months and are then safe for human consumption.

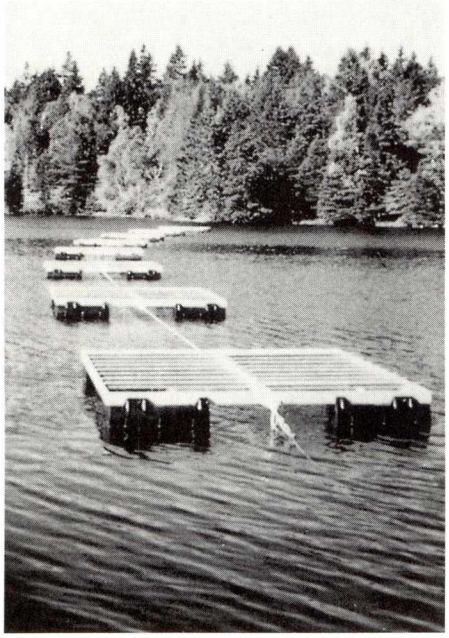
Up to now, most of the lessees have chosen the third alternative. However, increasing numbers are electing to collect their own seed oysters and rear them to market size.

A major problem in the Maritimes is a shortage of natural seed stock. Regrettably, due to the low water temperatures in some areas, setting of oyster larvae in commercially significant quantities does not occur every year in most areas.

To help solve the problem, the federal fisheries department set up an experimental oyster hatchery at Ellerslie, Prince Edward Island, in 1965. It was charged with developing reliable techniques for seed oyster production, assessing their commercial value, and encouraging development of private commercial hatcheries in the Maritimes. Although this hatchery demonstrated that oysters can be artificially spawned and reared successfully, the process proved too costly to be commercially viable.

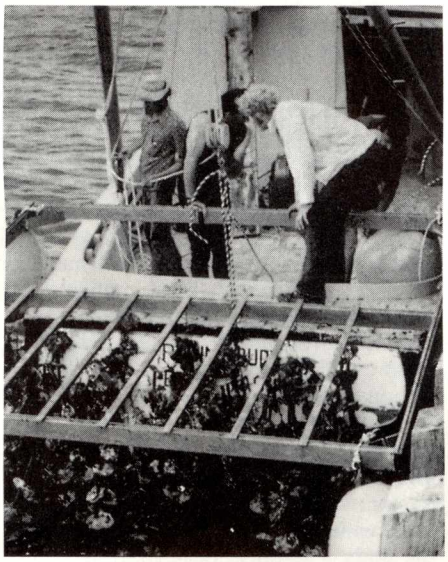
Off-bottom culture of oysters making use of rafts, floating longlines, and fences, has become popular in certain areas of the Maritimes, especially the Bras d'Or Lakes area. Instead of spreading the cultch over a bottom area, growers string it like beads on wire or nylon rope, then suspend it above the bottom at the appropriate time to collect the setting larvae. The collected spat are grown in suspension until they attain the desired length, after which they are separated from the cultch and either planted on the bottom or placed on trays suspended in the water to strengthen and repair their shells.

Held in suspension, oysters grow more rapidly and develop pumpler meats than on the bottom because better water circulation increases the availability of food. However, as a result of rapid growth, their shells tend to be thin. In order to produce shell qualities of the shape and thickness desired by Canadian consumers, the oysters need to be held for an additional year or two on the bottom or on suspended trays.



Oyster rafts moored in series.

Loading oyster rafts with T-bars threaded with strings of scallop shell spat collectors.



Off to Market

Canada's modest production of American oysters — a little over 1,361 t (*3 million lbs*) a year, in shell weight — is of high quality and is marketed in the shell. As the demand for them exceeds the supply, their price is relatively high, although it differs with the grade. The grade system classifies these oysters as *Fancy, Choice, Standard,* and *Commercial*, depending on shape standards which are based on the relationship between their length and width.

For the most part, Canadian Atlantic oysters are harvested in the fall. They are capable of living out of water for about four months, providing the temperature is maintained just above freezing and the atmosphere is damp. Packed in large wooden or cardboard boxes, they are shipped primarily to cold storage facilities in Montreal and Quebec City from where they are sold to retail stores, hotels, and large, organization-sponsored "oyster parties," Few, if any, are shipped west of Toronto and only an insignificant quantity is exported.

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