taken, the type and amount of feed it had been eating, its phase in the life cycle (molting or reproductive), it had been eating, its phase in the life cycle, and the storage life of the final product's storage life. Temperature. For all seafoods, the most important agent in preservation is refrigeration, −11° to 4°C (30° to 40°F), which at best only provides limited product life. Refrigeration merely retards deterioration—it cannot prevent it; thus, it must be accompanied by prompt and careful handling from harvest to consumption.

Keep it cold; keep it clean; keep it moving!

Frosting seafoods
Freezing is probably the simplest and most economical methods of seafood preservation. In itself, the process of freezing has no effect on the palatability or nutritional value of seafoods; however, even under the best conditions, frozen storage undergoes changes in flavor, odor, texture, and color. The rate at which these changes occur and the ultimate quality of the product depend on the kind and composition of the fresh product, on the way it was handled, the freezing conditions, and the stability of the storage temperature.

Kind and composition of seafood.
Not all seafoods are equally suited to freezing and storage. Structural, compositional, and physiological differences between and within species may influence the texture, flavor, and acceptability of the frozen product. Such changes are usually related to the proteins and oils of the product; generally, seafoods with high oil content and those going through certain physiological changes (reproductive, molting, etc.) have less tendency the freezing rate of the product undergoing materials. The rate at which a product freezes depends on the temperature and on the size, shape, and the exposure of the product.

Precaution should be taken not to overload freezers or to pack the unfrozen product too tightly. Either of these practices can greatly extend the freezing time of the product and reduce quality.

Storage temperature.
An other Important factor that influences both storage life and the quality of frozen seafood products is the temperature. Chemical and enzymatic changes that occur during storage are highly temperature-dependent and are markedly reduced as the storage temperature is lowered. Oil content, again, is significant: the higher the oil content, the greater the need for consistent low temperature. When possible, the seafood should be no higher than −18°C (0°F) throughout the storage period, except for those products that require a higher product temperature to ensure the handling, storage, and distribution of quality seafoods and sea products.

Fresh seafood handling
Proper handling and temperature control are essential to assure quality. When seafood is caught to the time it is prepared, to minimize changes that lower its quality or make it unusable as a food. To a large extent, handling procedures and the length of time seafoods are handled and stored determine the product's level of microbial growth and chemical and enzymatic reactions, all of which cause deterioration and spoilage. Of these three types of deterioration, microbial growth is the most important.

The flesh portion of freshly caught seafood is virtually sterile. However, bacterial contamination of the flesh is inevitable as the product is handled, then processed, and after distribution. These bacteria can die, remain dormant, or grow—depending on their type and the conditions under which they would spoil, and the requirements for proper handling and storage are considerably more exacting than for other perishable products. Conditions imposed by nature, and the methods by which seafoods are harvested and handled, only serve to make more difficult the problem of providing high-quality, wholesome products. Careful control of the temperature and chemical temperature control is essential in determining their ultimate quality in the frozen state. Although rapid freezing improves quality, this is a minor factor compared to the effects of storage temperature and packaging materials. The rate at which a product freezes depends on the temperature and on the size, shape, and the exposure of the product.

In addition to lowering the quality, improper storage or handling of seafoods can often the growth of food-poisoning organisms. As temperatures increase above 4°C (40°F), these organisms start to grow at an increasing rate. If storage temperatures are high enough and storage time is sufficient to allow substantial growth, they can pose a problem serious enough to warrant investigation by public health officials.

Fresh seafoods are also subject to chemical and enzymatic changes during storage; these cause off-flavors, off-odors, and loss of texture. Such unwanted changes, which are minimized by reducing storage temperatures, affect the proteins and oils of the seafood.

Factors that influence the kind and rate of spoilage
Kind of seafood. Different seafoods and even different species of the same seafood may differ considerably in their acceptability to consumers or in their perishability. Characteristic of the animals, its chemical composition, and even its size, may affect the ultimate quality and reduce the storage life of the product.

Condition. The condition of the seafood at the time of harvest has a decided effect on the acceptability and shelf life of the final product. The quality of water from which it was
Cleaning Water Temperatures
82°C (180°F) or above
Water for cleaning equipment, floors, walls, etc., must be a minimum of 82°C (180°F) at point of contact.

Danger Zone
4°C to 60°C (40°F to 140°F)
Within this range, food-spoilage and food-poisoning bacteria grow rapidly. Temperatures above 60°C (140°F) kill most bacteria; temperatures below 4°C (40°F) retard the growth of food-poisoning microorganisms. Therefore, foods should pass through the Danger Zone as rapidly as possible.

Critical Zone
4°C to 38°C (40°F to 100°F)
This is the growth range of most food-poisoning bacteria.

Fresh Storage Zone
-1°C to 4°C (30°F to 40°F)
These temperatures minimize the rate of food spoilage. Rule of thumb: for every 6°C (10°F) rise in storage temperature, shelf life is reduced by half.

Freezing Temperatures
-1°C to -3°C (27°F to 30°F)
At these temperatures, seafoods freeze, and most of the water is converted into ice.

Frozen Storage Temperatures
-18°C to -29°C (0°F to -20°F)
To maintain quality, frozen seafoods should be stored within this temperature range. Storage life doubles for every 6°C (10°F) decrease in temperature.

Quick Frozen
-29°C (-20°F) or lower
This term denotes the use of low temperatures and rapid freezing rates.

Keep it cold!
Keep it clean!
Keep it moving!
taken, the type and amount of feed must be promptly and properly handled aboard ship and throughout processing if the quality of the product is to be maintained. Conditions that lead to excessive bruising, or any damage to the skin or mucous membranes will reduce the final product's storage life.

Handling after the harvest. Seafoods must be promptly and properly handled at all stages from capture through processing. Attention to handling and processing prevents or delays the occurrence of deleterious reactions and thus maintains the quality of the最终 product. The rate at which these changes occur and the ultimate quality of the product depend on the kind and composition of the fresh product, the way it was handled and stored before freezing, the type and method of packaging, the manner of freezing, the freezing-storage temperature, and the stability of the storage temperature.

Kind and composition of seafood. Not all seafoods are equally suited to freezing and storage. Structural, compositional, and physiological differences between and within species may influence the texture, flavor, and acceptability of the frozen product. Such changes are usually related to the proteins and oils of the product; generally, seafoods with high oil content and those affected through certain physiological changes (reproductive, molting, etc.) have less satisfactory freezing qualities.

Freezing seafoods. Freezing is one of the simplest and most economical methods of seafood preservation. In itself, the process of freezing has no effect on the availability or nutritional value of seafoods; however, even under the best conditions, freezer storage results in a gradual decrease in the acceptability of the product. The extent of the deterioration of frozen storage undergoes changes in flavor, odor, texture, and even color. The rate at which these changes occur and the ultimate quality of the product depend on the kind and composition of the fresh product, the way it was handled before freezing, on the type and method of packaging, the manner of freezing, the freezing-storage temperature, and the stability of the storage temperature.

Handling before freezing. The ultimate quality of any frozen product depends on the quality of the fresh product. Freezing is only a method of preservation and will not improve inferior or improperly handled products. Delicate changes that are present in the fresh product are often intensified by freezer storage. Consequently, seafoods that are to be frozen must be properly and promptly handled under sanitary conditions and at reduced temperatures.

Packaging. The primary function of packaging is to protect the product from chemical and physical damage. Frozen seafood products lose quality at a rate inversely proportional to air (relative humidity) and are allowed to lose moisture (freezer burn). To minimize these changes, the products must be wrapped in specially designed materials that will minimize moisture loss, retard oxygen transmission, and resist oil absorption.

To minimize air spaces and voids, the proper packaging material must be tightly wrapped around the product. If products are loosely wrapped or have air spaces in the package, they lose quality because of reactions with the oxygen in the surrounding air and free radicals in the product moisture to the inside of the package (frost).

A water glaze may be used; it provides some protection from dehydration and the development of off-flavors (oxidation). In most cases, it should be used in addition to a packaging material. Areas where the glaze is not present or is cracked are subject to dehydration and the development of off-flavors.

rate of freezing. Within reasonable limits, the rate at which seafoods are frozen is not a major factor in determining their ultimate quality in the frozen state. Although rapid freezing improves quality, this is a minor factor compared to the effects of storage temperature and packaging materials. The rate at which a product freezes depends on the temperature and on the size, shape, and the exposure of the product.

Precaution should be taken not to overload freezers or to pack the unfrozen product too tightly. Either of these practices can greatly extend the freezing cycle of the product and reduce quality.

Storage temperature. Storage temperature is an important factor that influences both storage life and the quality of the frozen seafood product. In itself, freezing merely retards deterioration—it cannot prevent it; thus, it must be accompanied by prompt and careful handling from harvest to consumption.

Keep it cold; keep it clean; keep it moving!

Seafood spoilage and the requirement for proper handling and storage are considerably more exacting than for other perishable foods. Conditions imposed by nature, and the methods in which seafoods are handled and stored, only serve to make more difficult the problem of providing high-quality, wholesome products. Careful control of freezing temperature is essential in the handling, storage, and distribution of quality seafoods and sea products.

Fresh seafood handling. Proper handling and temperature control are essential if the freshness of the seafood is to be maintained. Handling and processing before the seafood is caught to the time it is prepared, to minimize changes that lower its quality or make it unusable as a food. As a large extent, handling procedures and the length of time seafoods are handled and stored determine the flavor, color, and texture of the product. At best, low temperatures temporarily slow or retard microbial growth and chemical and enzymatic reactions, all of which cause deterioration and spoilage. Of these three types of deterioration, microbial growth is the most important.

The flesh portion of freshly caught seafood is virtually sterile. However, bacterial contamination of the flesh is inevitable as the product is handled, packaged, and filleted. These bacteria may die, remain dormant, or grow—depending on their type and the conditions under which the product is stored. Although there is a variety of bacteria that exist on these products, lower temperatures markedly reduce the rates at which they reproduce. Good sanitary practices in handling, processing, and storage also help preserve the quality by minimizing contamination.

In addition to lowering the quality, improper storage or handling of seafoods can permit the growth of food-poisoning organisms. As temperatures increase above 4°C (40°F), these organisms start to grow at an increasing rate. If storage temperatures are high enough and storage time is sufficient, the products may become contaminated.

Condition of the seafood at the time of harvest is the best way to decide on the acceptability of the flesh after the final processing. The quality of water from which it was

Temperature control is critical. Get an accurate thermometer—and use it!

Seafood Processing and Marketing