BioNovations Inc.

Sustainable Solutions for the Live Seafood Supply Chain

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BIONOVATIONS INC®

Live Seafood Supply Chain Solutions

BioNovations Inc. manufactures technologically advanced systems designed for live seafood handling, holding, transport, as well as a wide variety of aquaculture applications. Through extensive R&D and with over 20 years of industry experience, BioNovations strives to provide the most sustainable infrastructure for the entire live seafood supply chain, from the fishing boat to the consumer's plate.

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Company Overview

BioNovations manufactures technologically advanced systems designed for handling, holding, and transporting live seafood. We are a locally owned and operated company based out of Antigonish, Nova Scotia, Canada. Our core business is providing solutions for the live seafood industry that are safe, reliable, and sustainable at all points along the supply chain. Our systems allow fresh live seafood to be distributed globally with greatly reduced mortality and shipping costs, so that the seafood industry can achieve its fullest value potential. Additionally, our systems are adaptable to a wide variety of aquaculture uses which is a fast-growing industry worldwide.

Product design at BioNovations is guided by our deep understanding of live seafood. We have designed our Traystor® Systems to replicate the natural conditions and cycles found in the aquatic ecosystem of each species. Our focus has been on both existing product improvement and proof of concept for new applications resulting in numerous proprietary components in our systems such as our particle filters, protein skimmers and biofilters. This has resulted in the development of a new innovative second generation of Live Holding Systems as well as the proof of concept for the BioNovations Live Seafood Transport and Container Systems.

BioNovations Traystor® brand of products minimize stress from catch to plate ensuring the health, freshness, and taste of the live product while reducing handling, mortality rates, packaging costs, and thereby increasing the overall market value of the seafood and providing transparency to the industry.

Product Quality is Key

Providing the end consumer with the highest product quality possible is the key to success for a live seafood supply chain. This maximises consumer satisfaction and ultimately increases supplier profitability.

The primary cause of degradation and mortality of live seafood is stress. There are numerous factors which can increase product stress, and each can be introduced at any step in the supply chain. The most common issues are emersion, excess handling, poor water quality, poor temperature control, proximity to other seafood and use of out-dated and insufficient infrastructure within the industry.

By developing a system which works to mitigate these stress inducing factors at all stages of the live seafood supply chain, BioNovations strives to provide suppliers with the facilities necessary to maintain the highest product quality possible, from catch to plate.

Common Problems with Traditional Supply Chain Practices

The existing methods by which live seafood is harvested, shipped, and stored allow many opportunities for stress factors to be introduced to live product as well as increasing costs associated with storage and transportation. The following examples highlight some of the existing issues.

Within traditional supply chain methods handling occurs at many points throughout the chain when transferring product from one stage to the next, checking for damages and dead product, etc. In addition to the potential physical stress caused by the handling, emersion often occurs during product transfers further reducing product quality.

Semi-open holding systems rely on a constant supply of seawater from the natural environment. This supply is often adversely affected by environmental characteristics such as shallow water, freshwater runoff, elevated silt concentrations, elevated temperatures, pollution, etc. Additionally, poor filtration methods of the product waste and the use of large cement ponds further impacts water quality. Semi-open systems typically use the outdated notion that “dilution is the solution to pollution” however it is proven that any of these water quality factors adversely affect product health.

In areas that fish in warmer waters, a semi-open system means significant costs associated with the required refrigeration and filtration to maintain clean seawater at the correct temperature. In the past, this made it impractical

to hold live seafood due to the high capital cost of the required infrastructure for a traditional semi-open or closed-loop recirculating system.

Currently, the primary means of transporting live seafood longer distances is by air, which is inherently expensive, unreliable, stressful to the seafood, and comes with high rates of spoilage and mortality.

In addition to all of this, there is a lack of ability to monitor critical conditions of the product in real time. This results in a lack of traceability and accountability throughout the life cycle of the product making it difficult to pinpoint the cause of failure when the quality of the seafood suffers.

BioNovations Traystor® Crate Supply Chain provides solutions for all aspects of live seafood supply chain, from catch to plate, all the while focusing on mitigating the stress factors and delivering the highest quality product to the end consumer.

BioNovations Traystor® Crate Supply Chain Overview

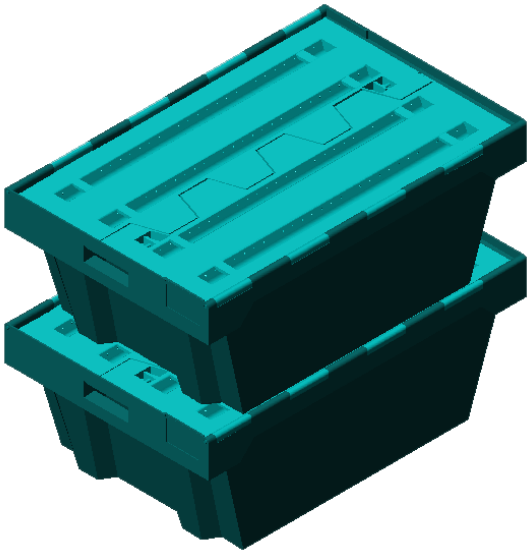
BioNovations Traystor® Crate Supply Chain gives the seafood industry the ability to control the handling, quality, and monitoring of their live product from catch to plate. BioNovations has developed the Traystor® Crate Supply Chain to reduce product stress as well as work with the Data Loggers, Internet-of-Things (IoT) Sensors, and RFID Tags to provide complete traceability to supplier and customer alike.

The centerpiece of the supply chain is the Traystor® Crate. The Traystor® Crates can be fitted with waterproof, wireless sensors that can be used to monitor critical conditions and provide real-time traceability. The sensors can track various water quality parameters with alarms sent via SMS text messaging, email, phone dialer, etc.

The BioNovations Traystor® Crate Systems can be utilized for live holding on vessels, for transporting short distances, purging, dockside storage (short-term holding), long distance transport and distribution centres (long-term holding).

Each seafood species is physiologically unique and has specific thermal and biological requirements which are considered in each Traystor® system. Each holding and transport system has its own Integrated Water Treatment System (IWTS) developed to be compact and efficient while meeting the physical, chemical, biological, and thermal requirements for the product species. These systems offer excellent water quality and conservation; instead of diluting waste the IWTS removes it. All components used in any Traystor® systems are saltwater compatible and made of food-grade material.

Traystor® Crate



The Traystor® Crate was designed and developed by BioNovations and is the keystone of the Live Seafood Holding and Transport Systems. Each crate has specially engineered vents and water flow channels to allow even water flow and oxygenation throughout the entire crate. Through internal channels, the circulating water continually removes all ammonia and other waste excreted by the product. At the same time the troughs in each Traystor® Crate lid act as large shower heads giving each crate the ability to transfer energy by convection.

Inside the Traystor® Crate, a plastic insert specially developed by BioNovations divides the product into individual vertical compartments. For lobster the thin plastic inserts are designed with a honeycomb arrangement of hexagonal compartments that are designed with the proper shape to hold each individual lobster in place. This optimizes the use of storage space within the crate allowing for the smallest volume of water per pound in the industry. The inserts eliminate agonistic and cannibalistic behavior, both major causes of stress for live lobster, as well as prevent abrasions on lobsters that can cause blemishes that can lead to the development of shell disease. Several different sizes of inserts are available so that the lobsters can be graded and separated accordingly into the Traystor® Crates right from the start to reduce handling and keep stress levels to a minimum. Once live product is removed from the Traystor® Crate, the plastic insert can be easily removed, collapsed, and placed flat back in the crate so that another identical crate can be nested and stacked inside. This reduces storage space requirements for the empty crates, thereby lowering transportation costs while allowing for optional return payloads in BioNovations Live Seafood Transport and Container Systems.

The Traystor® Crate also provides an innovative infrastructure to the valuable live seafood supply chain based on the Traystor® "One Touch" system. When utilizing the complete Traystor® Crate Supply Chain the Traystor® "One Touch" system means live seafood is handled only once as it is harvested, graded, and placed in the Traystor® crate by the harvester on the boat. Seafood companies will move the crates step by step throughout the supply chain without further direct handling of the live product. This innovative design allows the product to be checked for damages and mortality without further handling as the entire product is visible when the crate is opened. Even in some cases where seafood distributors will elect to re-sort the live product within the Traystor® Crates at their holding facility to fulfill specific orders, there is a significant reduction in handling of product.

To further simplify operations, BioNovations has developed a special forklift attachment to handle the Traystor® Crates. The forklift attachment eliminates the need for pallets and makes it easy to move the fully loaded or empty crates around. The forklift attachment comes either as a single or double attachment that can lift a stack one or two wide, from one to seven crates high. (i.e. up to 14 crates can be moved at one time)

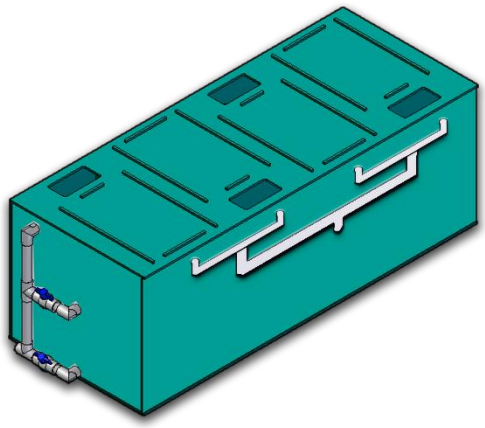
The Traystor® Crates can be stacked seven high, providing a product capacity of approximately 154 lbs/ft^2/stack. The Traystor® Crate is more efficient than conventional stacks of both the industry standard tote at 95 lbs/ft^2 and the IPL Cascade Tray at 94 lbs/ft^2 for holding American Lobster in stacks 7ft high.

The Traystor® Crates have also been used for multiple species, including wet storage for oysters, and can be adapted to suit the specific needs of any client.

Additionally, the Traystor® Crate was engineered so that it could also be used in the depuration of bivalves. By placing a false bottom inside the crate, it provides the live bivalves with the proper water circulation and product spacing required for controlled relaying and depuration as required by regulations under the Shellfish Sanitation Program in different countries.

BioNovations Traystor® Crate Supply Chain technology can utilize real-time tracking and monitoring to increase security, identify problems immediately, pinpoint accountability, and reduce liability, providing full traceability at all points along the supply chain, thus building confidence and trust between all parties. This can be achieved by installing trackers on the crates and companies, implementing a management system, to monitor product as it progresses through the supply chain.

Refrigerated Live Well Systems



The supply chain begins onboard the fishing vessel, once the live animal is removed from the ocean and graded; it is then placed in an individual compartment within a Traystor® Crate. The crate is held inside a live well onboard the boat to ensure they are kept in an optimal environment during the trip back to shore.

The live well can be run as an open system where water conditions allow for it but also can be equipped with a refrigeration system and run as a semi-open system where water temperatures are too high. This allows fisherman in a warmer climate and/or shallower water to maintain the optimal water quality while aboard the vessel, whether they are waiting in queue at the buy station or on a longer ocean-going trip. The system is designed to run off 12V or 24V power depending on what is available on the vessel and is custom built for each vessel to suit the spatial and operational requirements for each operator.

Refrigerated Truck Spray System

The buy station is a common source of stress for live product in the supply chain. It is common for the lobster to be stressed once they are dropped off at the buy station, where they often experience emersion and exposure to higher temperatures than the marine environment they just came from. Depending on the buy station and proximity to the purging/holding facility, there could be a significant time delay between the product coming ashore and getting to the facility.

BioNovations developed a Refrigerated Truck Spray System to be used with the Traystor® Crate at the buy station. Once ashore, crates are unloaded from the vessel and placed in the truck at the buy station while they wait to be delivered to a purging or short-term holding system typically at a different location nearby.

The trucks are designed for short distance travel while keeping the live seafood at a constant temperature and providing a source of top-quality refrigerated saltwater to the live animal by maintaining 100% humidity in the storage area of the refrigerated truck. The spray system maintains the wetness of the gills which is necessary for proper respiration and excretion of wastes by the live animals while out of water. The Refrigerated Truck system was designed for the use with the Traystor® Crate but can also be used to improve the quality of live seafood held in crates currently in use by the industry.

Purging and Holding Systems

Traystor® Crate Purge Systems

Most live seafood is harvested with food still moving through its digestive tract. The digested food and metabolic wastes must be removed from the animals to eliminate the build-up of toxins and to slow the animal's metabolism, which is necessary for preparing the live seafood for long term holding and/or transport. Traditionally purging takes place in the ocean where crates were floated allowing the natural action of the ocean water to remove the waste or held in large holding ponds flushed by high volumes of sea water from a nearby ocean. These techniques limit purging operations to only those facilities which are next to the ocean. Additionally, the temperature of the ocean water in many areas is simply too high for purging live seafood as the recommended temperature for purging

Homarus americanus lobster is between 8 to 9°C. Furthermore, environmental conditions may cause poor water quality due to sediment, storms, pesticide runoff, etc.

BioNovations has developed both closed-loop and semi-open Traystor® Crate Purge Systems. The systems are not only based on our patented Traystor® Crate technology but also our specially designed Traystor® Crate Inserts and our new innovative Manifold Water Delivery Systems (MWDS). The Traystor® Crate and the MWDS allows for the use of energy efficient air cooling. These Traystor® Crate Closed-Loop Purge Systems are the world's first fully automated, self-contained purge systems designed for flushing biological wastes from multiple species of live seafood using our Integrated Water Treatment System (IWTS). Using multiple stages and types of filtration techniques the harmful waste produced by live seafood is removed from the system as it is produced. The cooling and heating of system water is regulated by means of an environmentally controlled room. The clean, oxygenated water is further optimized by means of titanium chillers and heating coils to maintain the ideal water temperatures for whichever species is being held. BioNovations Traystor® Crate Systems are engineered to use gravity (the weakest of the four basic forces in nature) to make the system and all components have lower water and energy requirements than traditional holding facilities.

This system enables the seafood industry to effectively purge live product throughout the entire year, in any location using either fresh seawater or artificial seawater made to suit the specific species being held. By controlling temperatures and reducing toxins, the health and vitality of the seafood is maximized by minimizing stress to ensure the highest possible economical return. After the product is purged in a Traystor® Crate Purge System, the same Traystor® Crate can be put in a holding system or the Traystor® Crate Purge System itself can become a holding system by simply lowering the air and water temperatures. Additionally, the BioNovations Traystor® Crate can be used alone as a semi-open Purge System in places that have access to a good supply of clean, cold seawater.

An optional programmable logic controller (PLC) can be implemented into the systems to run all necessary equipment for the different biological and environmental requirements for the various seafood products. Since both the water and air temperatures are controlled, and the live product is held in a Traystor® Crate instead of large holding tanks of water, the purge system requires significantly lower amounts of water than current methods. This effectively reduces energy consumption and the costs associated with refrigeration, filtration, and pumping requirements.

Also, the facility can be designed such that the purging area is split into multiple smaller zones allowing the operator to run as little or as much volume as is required making the system more economical to operate.

Traystor® Crate Holding Systems

BioNovations began with its Traystor® TS1 and Traystor® TS3 First Generation Holding Systems, which are currently installed and operational in over 20 countries worldwide.

BioNovations has since developed the next generation Traystor® Crate Holding Systems. These systems operate like the Traystor® Crate Purge System, but with a simpler filtration system since live seafood generate much less biological waste after purging. As the innovative Traystor® Crate can retain water, it is effectively the holding system itself. The storage area can be split into multiple zones of any size and the operation then scaled to meet the demand as product stock levels fluctuate throughout the year.

Stacks of BioNovations Traystor® Crates are placed over a food-grade, above or in-floor catch basin, or within a large food-grade tank.

An environmentally controlled room is all that is needed to facilitate a BioNovations Traystor® Crate Holding System, as all plumbing is above-floor and included in the design of the system. This allows the Holding System to be easily installed into pre-existing rooms in warehouses, restaurants, and holding facilities, etc. without the need for new buildings, significant renovations, or additional construction. Since it is a closed-loop system, no water is received from or discharged to the natural environment or municipal services, making it easier to obtain regulatory approvals. The Traystor® Crate system significantly cuts down maintenance time, water requirements, and energy requirements which leads to substantial savings in costs and increases overall sustainability and profitability.

Live Seafood Transport Systems

Currently, the main means of long-distance transport is by airfreight, which is inherently expensive, unreliable, and stressful to the seafood. The typical method of packaging and shipping seafood creates a stressful environment for the product with the additional handling and emersion experienced. There is also an increased risk of damage to the product and all these factors ultimately result in degradation of quality and high mortality rates in product shipped using this method. As a result, many suppliers often ship more live seafood than was ordered to compensate for the expected losses which increases shipping cost for airfreight and packaging, while negatively impacting the bottom line. However, due to the expansion of Asian markets and time restraints of the airlines for delivery within 48 hours, there is a gap in delivery to these markets.

For long distance shipping, the Traystor® Live Seafood Transport System can provide this value-added product over large temporal and geographical distances. These transport systems are state-of-the-art, technologically advanced seafood holding systems, and are the only systems of their type in the world. The Live Seafood Transport Systems can be constructed within a van trailer, the Live Seafood Trailer System (LSTS), or a standard shipping container, the Live Seafood Container System (LSCS). These systems can transport to any location in the world over extended periods of time. The design of these systems ensures the highest quality of live product, giving the user considerable advantage over their competitors who use traditional transportation methods.

Both the LSTS and LSCS, utilizing the Traystor® Crate, will allow for more live product to reach the market unharmed and will open new markets where it was not possible to ship live seafood due to time or distance constraints. The Traystor® LSTS and LSCS are the only known system that allows large payloads (~25,000 lbs) of fresh live seafood to be transported around the world by road, rail, or sea, providing a cost effective and more sustainable alternative to air transport. The transport system operates on the same principles as the Traystor® Holding Systems except that the system is housed in an environmentally controlled multi-modal container or van trailer with a robust filtration system to maintain optimal water conditions. The Live Seafood Transport System is the world's first fully automated, self-contained transport system for multiple species of live aquatic animals that does not put the live animals in tanks of seawater.

Both the LSTS and LSCS function through technologically advanced biological and mechanical filtration systems, diesel electric systems, refrigeration, and water handling systems, which are all controlled by an onboard PLC computer system. The versatility of these systems enables the transport of many different species to various parts of the globe.

As with the previous stages of the Traystor® Crate Supply Chain the product remains in the Traystor® Crate as it moves from ship to shore to final domestic or foreign markets, eliminating the need for additional handling. The LSTS and LSCS will provide an alternative to costly air freight when shipping live seafood medium to long

distances and significantly reduces the carbon footprint associated with transportation. These systems allow the seafood industry to reduce shipping costs, eliminate expensive packaging, and to reach more distant markets with greater scheduling flexibility. At the same time, our Traystor® Crate technology reduces product stress and excess handling which improves health, maintains fresh taste, and lowers mortality rates.

Currently the Live Seafood Trailer System (LSTS) is in its final stages of development and expected to be in operation by early 2023. The Live Seafood Container System (LSCS) is currently in development and will follow closely behind the LSTS, expected to be ready for operation by mid 2023 as both systems utilize much of the same technology.

Traystor® Crate Distribution Centres

The need for quality control in foreign jurisdictions is driving seafood distributors to establish live seafood distribution centres in those areas where product can be shipped internationally within the company. It can then be sold from the distribution centre without any dispute over the quality of the product as often occurs when product is shipped directly to a foreign buyer.

BioNovations has developed the Traystor® Crate Distribution Centres to allow large expandable systems to be established that integrate with BioNovations Traystor® Supply Chain, providing the freshest live seafood to the entire world. These Centres now make it easy and practical to have large inland, closed loop holding systems not only in foreign jurisdictions, but also domestically.

BioNovations Traystor® Crate Distribution Centres are based on the same principles as the Traystor® Crate Holding Systems but are engineered to accommodate the larger volume of live seafood associated with a large central distributor. The Traystor® Crate Distribution Systems are also designed around stacked Traystor® Crates on a food grade floor surface. Water run-off from the crates will go through a trench to a catch basin and be cleaned by multiple stages and types of filtration in the Integrated Water Treatment System before being recirculated to the product crates. Furthermore, the design of the Traystor® Crate provides the necessary water circulation, aeration, and cooling required for sustaining the life and quality of the seafood over long periods of time.

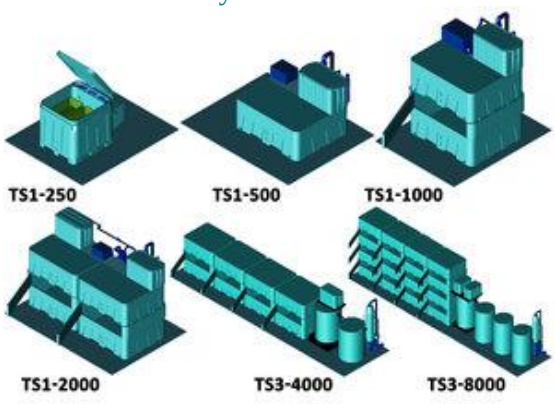
The storage area of the system is an open floor concept to receive the stacks of crates from BioNovations Live Seafood Transport Systems and can operate with as little as one stack (~700 lbs) or as many as required by the individual customer. The Distribution Center can be broken down into many small zones making it easy to scale the operation up or down based on product availability and customer demand at any given time.

BioNovations next generation of systems are specifically designed to complete the distribution network necessary to increase exports of live seafood through improved energy efficiency, reduced handling, and decreased mortality while maintaining quality control and traceability throughout the supply chain. These second-generation systems, all based on our patent pending Traystor® Crate technology, will provide seafood distributors accessibility to new markets around the world as well as allow new markets to be established where none existed before.

Retail/Small Scale Holding Systems

In addition to large scale distribution centers and development of long-distance transportation technology, BioNovations also offers smaller scale live product holding systems. These are typically used by individual harvesters or restaurant/store owners for storage and/or display. All of the same filtration and technology goes into these systems which are inherently designed to be closed loop systems.

First Generation Systems

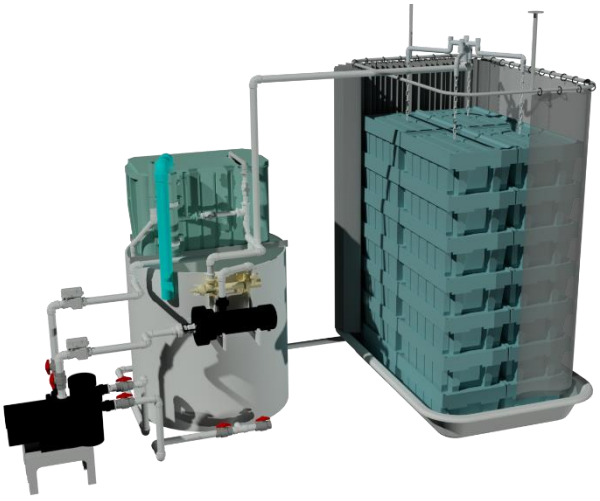


The First Generation Traystor® TS1 and TS3 Holding Systems are turnkey, closed-loop live seafood holding systems designed around the Traystor® I and Traystor® II holding tanks. These systems are manufactured in various sizes. The Traystor® TS1 Holding Systems have holding capacities from 250lbs to 2,000lbs and arrive on site ready-to-operate. These First Generation systems utilize a covered rectangular tray for holding product.

The Traystor® TS3 Holding Systems have a larger capacity designed uniquely for each customer using the Traystor® II holding tanks as the building blocks of each system and are assembled on site. Our trademarked Traystor® I and II Holding Tanks, used with these systems, are insulated enabling them to be used in almost any setting, such as restaurant kitchens or walk-in freezers, and in many climates from northern Alaska to tropical Bangkok.

The First-Generation live seafood holding systems are currently installed and operating in 20 countries worldwide supporting a wide range of live seafood, and because they are food-grade, many universities use them for research and development. Our Traystor® TS1-250 holding system is also being used to transport live seafood in smaller operations. As part of our ongoing research and development, done in conjunction with university research facilities, BioNovations used a Traystor® TS1-250 to hold lobster from the Nova Scotia Gulf Region for six months with 0 % mortality.

Next Generation Hybrid Systems



Utilizing the Traystor® Crate and difference Containment Basins, BioNovations has developed hybrid systems that can hold from 2,800 to 8,000 lbs. of product.

The Integrated Water Treatment System (IWTS) is the same technology used in the larger distribution centers however scaled down to suit the size of the application. These systems are placed in a refrigerated space and typically include water cooling as well to ensure correct product temperature is maintained. The system can also be configured in numerous ways to suit the customer's spatial requirements.

Existing BioNovations customers can expand the capacity of their TS1 and TS3 Holding Systems seven-fold by switching to our next generation system with minimal renovations. Traditionally, each Traystor® II Holding Tank was used to accommodate 500 lbs of product by completely filling the tank with seawater to submerge the live animals. By modifying the system, to work with the Traystor® Crate, the Traystor® II Tank becomes the catch basin to hold 35 stacked Traystor® Crates and significantly increases the system capacity from 500 lbs to 3500 lbs. This modular design allows each system to easily expand by simply adding more Traystor® II Holding Tanks or a Containment Basins on which additional Traystor® Crates can be stacked.

Summary

BioNovations innovative systems substantially increase reliability, sustainability, and profitability throughout the entire live seafood supply chain by reducing handling, stress, packaging, mortality, as well as logistical and operating costs which we know will help reduce these shrinkage numbers and help the seafood industry develop a standard quality for many products.

BioNovations Traystor® Crate Holding Systems have quality for Nova Scotia Live Lobster Quality Certification Program were tray and crate are not inadmissible for certification to hold lobster over 14 days if they done have a provision of individual compartments because lobsters are solitary animals.

Whether you are a big or small operation, buyer, distributor, or retailer, if you deal with live seafood products BioNovations has a product that can be of benefit to you.

Contact Info

Please contact us with any inquiries. Our systems are all purpose built and can be customized to suit any needs.

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