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# Digital Traceability *for* Oyster Supply Chains: Implementation and Results of a Pilot


By

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The sustained participation of all parties, including the plant personnel and vessel captains that handled handheld scanning devices and tags on a daily basis also made the pilot successful. In particular the pilot team acknowledges the following industry participants for their extended efforts in implementing the pilot in their businesses: Jason Gilfour and Motivatit Seafoods of Houma, LA; Jennifer Jenkins and Crystal Seas Oysters of Pass Christian, MS; Brad and Don Robin of Cajun Shellfish of Hopedale, LA; Michael Ketchum and New Orleans Fish House of New Orleans, LA; and John Graham, Rob Heffner, and Kevin Fish of Half Shell Oyster House in Biloxi, MS.

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## Executive Summary

While the oyster industry has a long history of traceability, the present manual approach is struggling to adequately meet the contemporary needs of the industry. The oyster traceability pilot described herein investigated how the current handwritten harvest tags are capable of being extended to integrate with a digital traceability system. The motivation for the pilot was to explore how improved traceability can assist the U.S. Gulf of Mexico (Gulf) oyster industry with existing and new challenges.

The Gulf oyster industry has recently faced several extraordinary natural and manmade challenges, ranging from hurricanes to an unprecedented oil disaster. In addition, new regulations such as The Food Safety Modernization Act and the Bioterrorism Act are adding increasing demands and strains on the industry. In an attempt to overcome these obstacles, the Gulf States Marine Fisheries Commission sponsored the pilot as a part of the Oil Disaster Recovery Program.

Significant industry involvement allowed the pilot team to perform a detailed analysis of the current manual harvest tagging methodology and evaluate how digital tags could improve accuracy, efficiency, and trust over the current manual tags. Based on these findings, the pilot defined, developed, and tested a solution that met the requirements of the Gulf oyster industry for tagging, data capture, and traceability. The system was designed to deliver a robust, efficient, and comprehensive information management solution that focused on ensuring compliance with state and federal regulations by efficiently delivering critical information about Gulf oysters to buyers and consumers.

Working with both large and small companies, the pilot proved that a fully digital oyster traceability system can be successfully implemented from harvest to plate. It was shown to help the oyster industry with its traceability challenges, such as performing a complete trace back and track forward of the full supply chain. The benefits of electronic scanning were also shown to help reduce risk at harvest, processing, distribution, and consumption by providing enhanced information and timely access.

Integrating the recording of Critical Tracking Events and Critical Control Points into one system was also demonstrated through the pilot. It was shown that the recording and tracking of these Enhanced Traceability Events can be utilized to improve the overall efficiency of oyster supply chains by moving toward a more proactive paradigm.

Nonetheless, there are still challenges to full implementation such as connectivity and participation. The key to overcoming these challenges lies with generating support from all levels of the industry. With industry support, a digital handheld scanning solution is a win-win for all who depend on Gulf oysters.

## 1. Introduction

The goal of the oyster traceability pilot was to develop and test a digital traceability solution for the Gulf oyster industry supply chain. The aim of the solution was to deliver an electronic information management system that could address some of the current challenges of the industry by enabling the sharing of key information securely between trading partners as product moved through the supply chain.

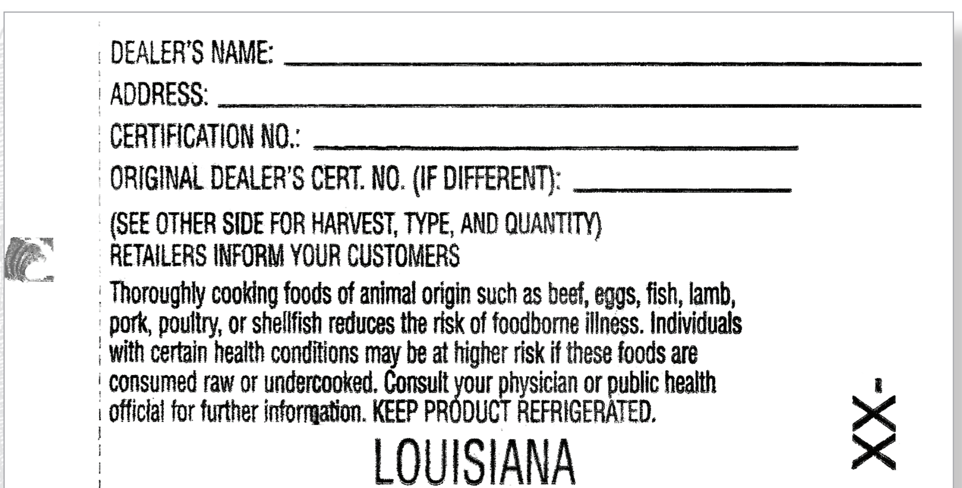
The pilot investigated several unique regulatory compliance requirements of the oyster industry, such as temperature monitoring, tag tracking, and internal traceability at the oyster harvester, processor, distributor, and foodservice provider. Through the use of hardware, software, and tag tracking technologies, the pilot enabled enhanced functionality for internal traceability management and the integration of temperature recording.

The pilot was executed in two phases over 23 months. Phase I started in October of 2011 and was completed in January 2012. Phase II commenced in April of 2012 and was completed in August of 2013. During Phase I, a detailed analysis of the current manual tagging and information management systems used by oyster businesses throughout the Gulf was conducted. This phase identified the requirements needed to apply software and hardware in an effort to improve efficiencies, reduce costs, and address data gaps throughout the supply chain. Phase II of the pilot consisted of using the requirements identified in Phase I to pioneer a digital traceability solution for the oyster industry.

### A. Pilot Overview

#### Background

Handwritten tags have long been implemented as a traceability tool for the oyster industry (Figure 1). The existing manual system, however, is struggling to meet federal and state regulatory demands and may lead to an increased risk of non-compliance and lost business.



DEALER'S NAME: ____________________

ADDRESS: ____________________

CERTIFICATION NO.: ____________________

ORIGINAL DEALER'S CERT. NO. (IF DIFFERENT): ____________

(SEE OTHER SIDE FOR HARVEST, TYPE, AND QUANTITY)

RETAILERS INFORM YOUR CUSTOMERS

Thoroughly cooking foods of animal origin such as beef, eggs, fish, lamb, pork, poultry, or shellfish reduces the risk of foodborne illness. Individuals with certain health conditions may be at higher risk if these foods are consumed raw or undercooked. Consult your physician or public health official for further information. KEEP PRODUCT REFRIGERATED.

LOUISIANA

XX

**Figure 1. Louisiana's Oyster Harvest Tag**

### Benefits of Digital Traceability for Oyster Supply Chains

The following were identified as potential benefits of a comprehensive electronic tagging and data capture solution for the Gulf oyster industry:

- Food Safety
    - Improve the frequency of successful trace backs
    - Reduce the need for frequent category wide recalls
    - Narrow the scope of product recalls

- Efficiency
    - Reduce the cost of reading tags
    - Reduce the number of data errors
    - Reduce the cost of audits
    - Reduce inefficiencies and waste in the supply chain
    - Reduce the cost of finding and segregating impacted products

- Sustainability
    - Reduce the waste of wholesome products

### Business Drivers

The business drivers for the pilot were as follows:

- Increase the success during an identified food-borne illness outbreak with respect to
    - Identification of source area
    - Identification of entities that have received oysters from an identified area
    - Speed and efficiency of a recall

- Increase the ability to track and manage commingled products at a
    - Processing plant
    - Foodservice provider

- Increase efficiencies through the overall traceability process by
    - Recording information
    - Assimilating information
    - Identifying locations of specific oyster products
    - Associating additional information with products

## B. Phased Approach

The pilot was executed in two phases over about two years. Phase I was a requirement-gathering phase, while Phase II consisted of piloting and investigating different options to develop a solution.

## Phase I – Requirements Gathering

The objective of Phase I was to capture requirements from the industry, government agencies, and industry organizations. The requirements stemmed from conversations and interviews with respective stakeholders. Requirements were also captured and reviewed on February 14th, 2012 during a digital oyster tag requirements meeting held in New Orleans, LA. Twenty-six representatives from the industry, government, and industry groups attended the one-day meeting (Table 1).

**Table 1. Participants of the Digital Oyster Tag Requirements Meeting**

| Name | Agency/Address |
|---|---|
| Scott Bannon | Alabama Marine Resources Division |
| Claude Petersen | BlueFin Data, LLC |
| Alexander Miller | Gulf States Marine Fisheries Commission |
| Ralph Hode | Gulf States Marine Fisheries Commission |
| Ken Moore | Interstate Shellfish Sanitation Conference |
| Rhonda Caronna | Joey Oyster Inc. |
| Vito Caronna | Joey Oyster Inc. |
| David Guilbeau | Louisiana Dept. of Health and Hospitals |
| Gordon LeBlanc | Louisiana Dept. of Health and Hospitals |
| Gary Lopinto | Louisiana Dept. of Health and Hospitals–Commercial Seafood |
| Darren Bourgeois | Louisiana Dept. of Wildlife and Fisheries |
| Jason Froeba | Louisiana Dept. of Wildlife and Fisheries |
| Mark Schexnayder | Louisiana Dept. of Wildlife and Fisheries |
| Rene LeBreton | Louisiana Dept. of Wildlife and Fisheries |
| Al Sunseri | Louisiana Oyster Task Force / Gulf Oyster Industry Council |
| Joe Jewell | Mississippi Dept. of Marine Resources |
| Ruth Posadas | Mississippi Dept. of Marine Resources |
| Mike Voisin | Motivatit Seafoods |
| Karen Billiot | Prestige Oysters Inc. |
| Lynette Bagal | Prestige Oysters Inc. |
| Aneline Brown | Psion |
| Lance Robinson | Texas Parks and Wildlife Dept. |
| Dag Heggelund | Trace Register |
| Jaimy Norris | Trace Register |
| Micah Parker | Trace Register |
| Phil Werdal | Trace Register |

During Phase I, it was determined that the digital traceability solution needed to provide the following:

- Internal Traceability
- External Traceability
- Integration with Hazard Analysis and Critical Control Points (HACCP)

With traceability defined as the ability to verify the history, location, or application of an item by a means of documented recorded identification, the requirements-gathering phase of the pilot determined that

- Product flow is not strictly linear
- Products are combined or commingled
- Products are transformed

These observations made it clear that a message-based solution was required. The implementation and description of this approach is detailed in Section 4: Overall Process: Critical Tracking Events (CTEs) and Key Data Elements (KDEs).

As products move through the supply chain, certain actions are performed to the products, and certain measurements are taken. To develop the requirements for the pilot, the following specific terminologies were defined:

- Facility: a physical location containing one or more stations
- Station: a physical location within a facility where a specific set of events are recorded
- Event: a specific action or occurrence that is performed and recorded at a station
- CTE Header Fields: See Table 3 for header fields and their respective definitions

### Phase II – Piloting

Phase II focused on piloting different options to develop a solution that would meet the requirements defined during Phase I of the pilot. A steering committee was formed in an effort to maintain continued participation from industry and government representatives throughout the duration of the pilot.

The steering committee met on a monthly basis to review progress, address technical changes, and ensure that the pilot was moving in a direction supported by both industry and government representatives. The meetings were held primarily as conference calls with occasional face-to-face gatherings as needed. The pilot steering committee proved to be essential to the success of the pilot and consisted of the individuals listed in Table 2.

**Table 2. Pilot Steering Committee**

| Name | Organization |
|---|---|
| Ken Moore | Interstate Shellfish Sanitation Conference |
| Mike Voisin | Motivatit Seafoods |
| Alexander Miller | Gulf States Marine Fisheries Commission |
| Cindy Bohannon | Texas Parks and Wildlife Dept. |
| Darren Bourgeois | Louisiana Dept. of Wildlife and Fisheries |
| Rene LeBreton | Louisiana Dept. of Wildlife and Fisheries |
| Mark Schexnayder | Louisiana Dept. of Wildlife and Fisheries |
| David Guilbeau | Louisiana Dept. of Health and Hospitals |
| Gary Lopinto | Louisiana Dept. of Health and Hospitals -Commercial Seafood |
| Gordon LeBlanc | Louisiana Dept. of Health and Hospitals |
| Jon Bell | Louisiana State University |
| Nicole Shaffer | Alabama Marine Resources Division |
| Paul Balthrop | Florida Dept. of Agriculture & Consumer Services |
| Phil Werdal | Trace Register |
| Micah Parker | Trace Register |
| Dag Heggelund | Trace Register |
| Susanne Rogers | Trace Register |
| Ruth Posadas | Mississippi Dept. of Marine Resources |
| Jason Gilfour | Motivatit Seafoods |
| Jennifer Jenkins | Crystal Seas Oysters |

## C. Pilot Requirements, Components, and Deliverables

### Pilot Requirements

Using information collected from industry and government, the steering committee identified the following requirements that the solution needed to attempt to meet:

- Work for the entire supply chain, from harvester to foodservice provider
- Work for large and small supply chain participants
- Work for a supply chain in which the harvester or first receiver does not participate
- Meet the internal traceability requirements of a complex oyster processor, specifically tracking and tracing commingled products
- Introduce a higher level of traceability for foodservice providers
- Integrate with the current electronic trip ticket system
- Include HACCP Critical Control Points (CCPs) such as time and temperature

### Primary Components

With the pilot requirements identified, the primary components for the overall solution were outlined by the pilot team as follows:

- Digital Tags
- Hardware
- Software (technology stack)
- Overall Process (methodology)

### Key Deliverables

Based on the requirements defined by the steering committee and the components outlined by the pilot team, the key deliverables were as follows:

- Results from the use of Quick Reference (QR) codes on oyster tags by the following methods:
  - Printed QR-coded stickers applied to an oyster tag onsite in real-time
  - Preprinted QR-coded oyster tags
- Results from investigations into to the use of additional digital tagging options using the following:
  - Radio-Frequency Identification (RFID)
  - Near Field Communication (NFC)
- Integrated temperature recording as a function of time from independent temperature readers
- Results from investigations into handheld scanning device hardware options using the following:
  - Psion Workabout Pro 3 handheld computer
  - Nokia Lumia 920 smartphone
- Development of software for handheld scanning devices
- Integrated digital tagging with the following existing electronic systems:
  - Trace Register's Traceability Platform
  - BlueFin Data's Electronic trip ticket system
- Defining the overall process to document the path oysters take through the supply chain using the following:
  - CTEs
  - KDEs
- Results from implementing the digital solution with industry participants

- Results of a trial recall scenario
- Identifying findings, challenges, and recommendations related to a digital solution for participants throughout the oyster supply chain with respect to:
    - Digital Tags
    - Hardware
    - Software
    - Overall Process

## 2. Digital QR-Coded Oyster Tags

Oyster harvesting tags have been used by the oyster industry throughout the United States for decades. The tags vary among the states, and are often available in various colors to indicate post-harvest processing requirements. Requirements are different by state as to when a tag needs to be attached to a specific harvest, with some states mandating that the tag be attached to a sack at the location of harvest. Oyster tags are generally purchased from a state agency, and many states have a unique number attached to each tag, which is not generally utilized by the industry.

As products are processed, new tags (or existing tags) are attached to the product. The tag information includes the harvest date, harvest area, and dock/dealer identification number. A key challenge is the fact that information about the product, such as the temperature and production time, is kept separate from the tag. Additionally, the manual tag does not show other lots the tag was commingled with, whereas information associated with digital QR code technology has the ability to do so. The manual implementation also does not accommodate a uniform method for obtaining all associated information about the product when an oyster tag arrives at the end of the supply chain such as at a foodservice provider (restaurant).

### A. Description

The standard oyster harvest tags historically used in Louisiana and Alabama are presented in Figure 1 above and Figure 2, respectively.

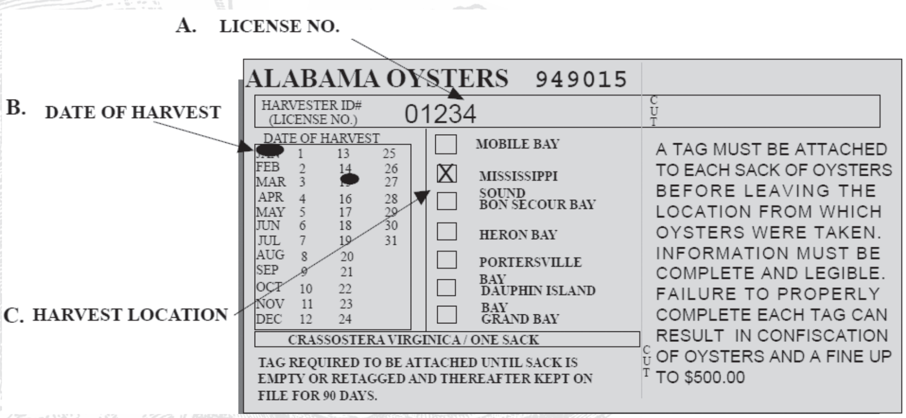



**Figure 2. Alabama's Oyster Harvest Tag**

The Louisiana oyster harvest tag, with the addition of a QR code used for the pilot, is shown in Figure 3.

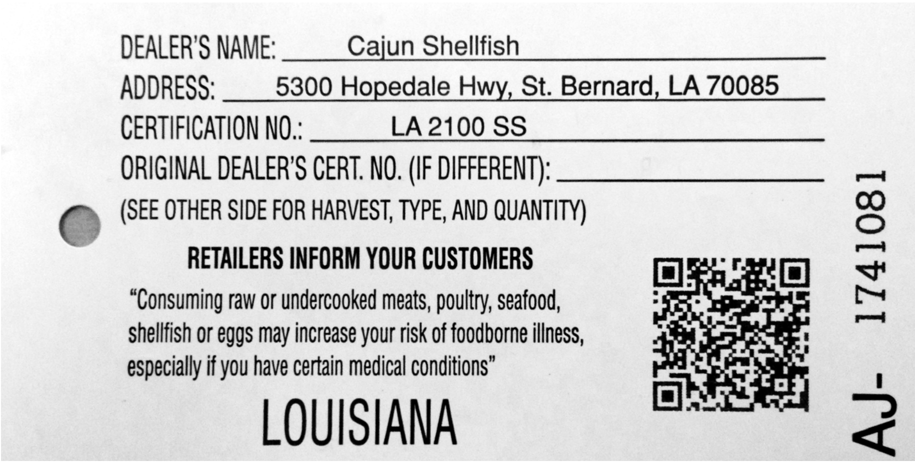



**Figure 3. Louisiana's Oyster Tag including a QR Code**

## B. Tag Management

One essential requirement for the piloted solution included the fact that the QR code for each tag needed to be unique, regardless of when or who generated the QR code. The piloted solution addressed this problem by the use of a 128-bit Globally Unique Identifier (GUID). The GUID assigned a globally unique number to each oyster harvest tag. Each GUID for the pilot was used as the primary link to an online database that stored and tracked additional information about the oyster harvest tag. As products were aggregated or transformed, new identifiers (IDs) were generated for each new product using a QR code. An example of this procedure is shown in Figure 4.


**Figure 4. Transformation Results of a New Tag ID**

As new oyster harvest tags were created, links to the source tags were also stored in the online database. Key information stored and associated with each oyster tag was referenced through CTEs and KDEs. A more in-depth discussion of CTEs and KDEs is presented in Section 4: Overall Process: CTEs and KDEs.

At the start of harvest, a handheld scanning device was used to enter standard trip and harvest information. During a trip, QR-coded tags were attached to individual sacks during harvest and were scanned before being placed in the cooler, which resulted in the following:

- A new product being created with the scanned ID
- The associated tag and trip information being stored as part of the ID, which included vessel name, harvest area, harvester ID, and date and time

In addition to each CTE scan, the complete header fields were also stored. Table 3 and Table 4 present example CTE event header fields and CTEs.

**Table 3. Critical Tracking Event Header Fields**

| Field | Description |
|---|---|
| **Entity** | The entity that has ownership of the location |
| **Product ID** | The GUID of the product. For aggregated and transformed CTEs this represented the new item, i.e. the ID for a pallet. |
| **Date and Time Stamp** | When the item was scanned |
| **Location ID** | A unique location belonging to the entity. This was often referred to as a “station.” |
| **Event** | The type of CTE event. Examples of CTE events are presented in Table 4. |

**Table 4. Critical Tracking Events**

| CTE Type | Description | Notes |
|---|---|---|
| **Creation** | A new product is created in the supply chain. | |
| **Aggregation** | A new product is created by collating existing products into a single product. | Reversible |
| **Transformation** | A new product is created by mixing/transforming existing products into a single new product. | Not reversible |
| **Business Transaction** | A product changes ownership. | |
| **Delivering/Sending** | A product is delivered/sent to a new location. | |
| **Receiving** | A product is received at a new location. | |
| **Moving** | A product changes location. | |
| **Depletion** | Product is used. | |
| **Disposal** | Product is disposed of, not used. | |
| **Object** | Information, such as inventory changes, is associated with the object. | |

### C. Communicating and Associating Information with QR-Coded Tags

As events were often recorded where internet access was not available during the pilot, it was necessary for the software solution to operate in a disconnected mode. This requirement was met through the design of the software, which stored data in a local cache and subsequently provided functionality for uploading data to an online database when a connection was available.

In a product production or processing environment, it was important that each device could operate in a stateless[1] manner while disconnected, and, when feasible, connect and upload recorded data at a later time. The three main reasons for this requirement are described below.

- In the processing plant, many devices were used at the same time, and some of the devices operated in a disconnected mode.
- Internet connections were not 100% reliable, and stopping production due to a broken internet connection was not an option.
- Synchronization between all devices would have resulted in a fragile system architecture, and if one operator failed to record a CTE, the pilot team did not want the downstream connections in the supply chain to be rendered unavailable.

### D. Findings and Additional Requirements

During field testing of the digital QR-coded oyster tags, many new and sometimes unexpected requirements were revealed for vessels, dock/dealer facilities, processing plants, distributors, and foodservice providers. In addition, several valuable lessons were learned from each component of the supply chain.

#### Vessels

The use of portable printers for stick-on QR codes on harvest vessels was initially investigated as a potential option for digital oyster tagging (Figure 5). After the pilot team accompanied the crew during harvest, it became clear that the use of onboard printers was not a viable solution, and the use of pre-printed QR-coded oyster tags was implemented. Crew members' use of languages other than English was also a challenge and resulted in the development of a graphical user interface that used both pictures and text. The pilot team also discovered that vessel owners had varying degrees of requirements, with some requiring that the oysters be sorted by grade. The modular design of the software solution, however, allowed for different configurations to be applied to different vessels. The handheld scanning device used on vessels during the pilot, the Psion Workabout Pro 3, held up to the harsh environment, continued to work properly when dropped, and was consistently exposed to salt water.

[1] The term "stateless" refers to the fact that each handheld scanning device did not need to know (or have knowledge) of what the other devices were doing during operation. If the devices were not designed as stateless, they could not have operated in a disconnected state.

**Figure 5. Harvest Vessel**

*Lesson Learned: The software solution must support custom configurations for CTEs, KDEs, and different locations or stations.*

### *Temperature Recording During Harvest*

Temperature recording during harvest was also explored during the pilot and integrated with the digital QR-coded oyster tags. The pilot team worked closely with Pole Star Space Applications, the Vessel Monitoring System (VMS) provider for the Louisiana Department of Wildlife and Fisheries. The design for the recording system implemented at the vessel level is shown in Figure 6.

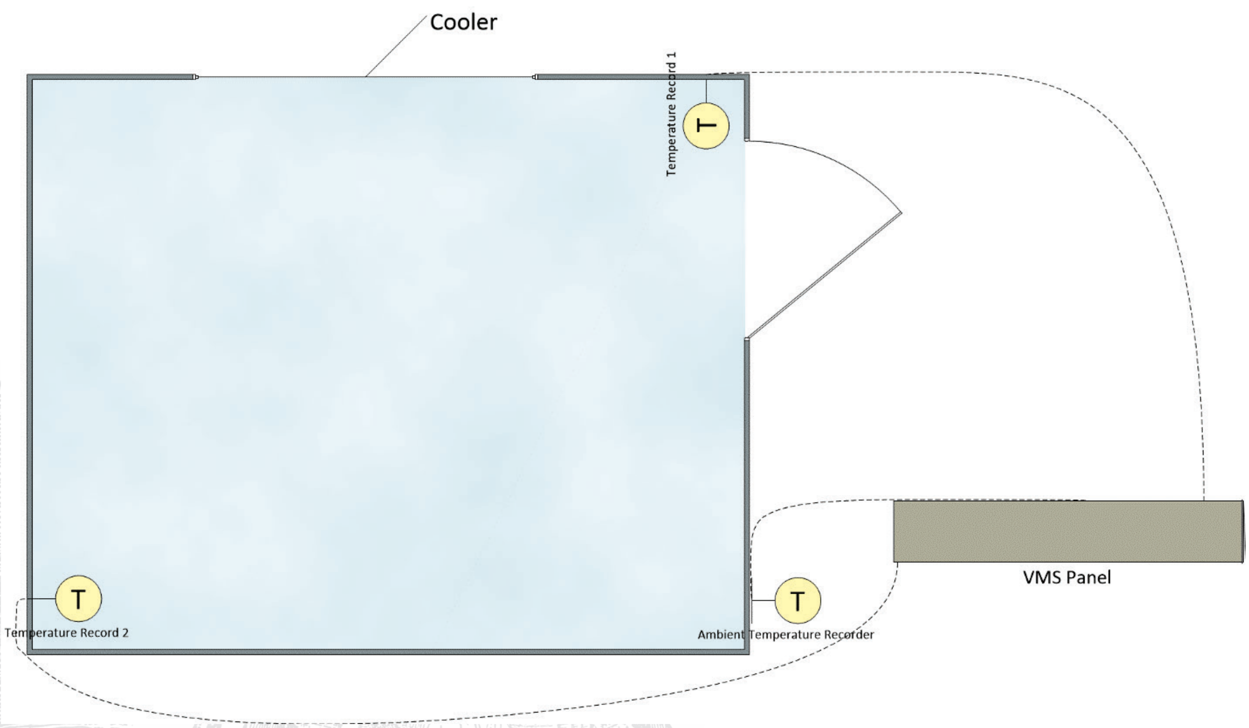



**Figure 6. Temperature Sensors at the Vessel Level**

At the start of harvest, the harvester pressed the start record button, and subsequently, all three temperature readings were sent via satellite every six minutes to the Pole Star Space Applications server. Example recordings are shown in Table 5.

**Table 5. Example Vessel Temperature Recordings**

| Time | Temp 1 | Temp 2 | Ambient Temp. |
|---|---|---|---|
| 8:00:00 8/1/13 | 48 ºF | 42 ºF | 75 ºF |
| 8:06:00 8/1/13 | 47 ºF | 41 ºF | 76 ºF |
| 8:12:00 8/1/13 | 46 ºF | 40 ºF | 77 ºF |

As each oyster sack was placed in the cooler, the sack was scanned, and a CTE was recorded. As the sack was offloaded, the sack was also scanned. Example CTE data recordings are presented in Table 6.

**Table 6. Example Harvesting CTE Recordings**

| Harvest Sack ID | CTE: Registered | CTE: Into Cooler | CTE: Offloaded |
|---|---|---|---|
| ID 1 | 10:01:04 8/1/13 | 10:01:32 8/1/13 | 12:01:00 8/1/13 |
| ID 2 | 10:02:04 8/1/13 | 10:02:32 8/1/13 | 12:01:04 8/1/13 |
| ID 3 | 10:03:04 8/1/13 | 10:03:32 8/1/13 | 12:01:08 8/1/13 |

Combining the results of Table 5 and 6, Newton's Law of Cooling[2] was used to calculate the temperature profile of each oyster sack and assign the calculated temperature of the sack at the time of offloading. The following challenges occurred during the implementation of the temperature recordings:

- Many harvesters were skeptical of participating.
- Newton's Law of Cooling needed to be calibrated for the actual configuration of the individual coolers on the vessel.
- The temperature recording did not fully meet the requirements of recording the actual meat temperature of the oyster.

*Lesson Learned: Temperature recording on harvesting vessels needs additional investigation before it can be fully deployed. An educational program should be undertaken to ensure that proper information is communicated to harvesters. Also, clear guidelines with respect to how the data will be used and how it will not be used need to be established.*

## Dock/Dealer Facilities

One key challenge to piloting the digital scanning solution at dock/dealer facilities was the lack of internet access. This problem was solved through the purchase and installation of cellular Wi-Fi transmitters on each of the docks/dealers participating in the pilot. A second challenge occurred when oysters were unloaded at the dock/dealer as some of the tags were placed on the bottom of the sack, resulting in dirt

[2] Calibration of the calculations were performed by updating measurements from the cooler at the Motivatit Seafoods facility.

collecting on the tag and QR code. The pilot team addressed this issue by instructing harvesters to ensure that the tags were placed on the sacks where they would not be exposed directly to the floor. The use of pre-printed QR codes instead of stick-on QR codes also made it easier to remove dirt from the QR code without damaging it.

*Lesson Learned: It is important that dock/dealer facilities have internet access. Wireless via Wi-Fi transmitters is an effective solution.*

*Lesson Learned: Dirt may interfere with the reading of the QR code on the oyster tag.*

## Processing Plants

A key goal of the pilot was to address the complex internal traceability issues for oyster processing plants. The complexity of the participating processing facilities varied greatly from two traceability stations to more than 20 stations or locations. One example of an oyster processing plant with significant complexity is shown in Figure 7.

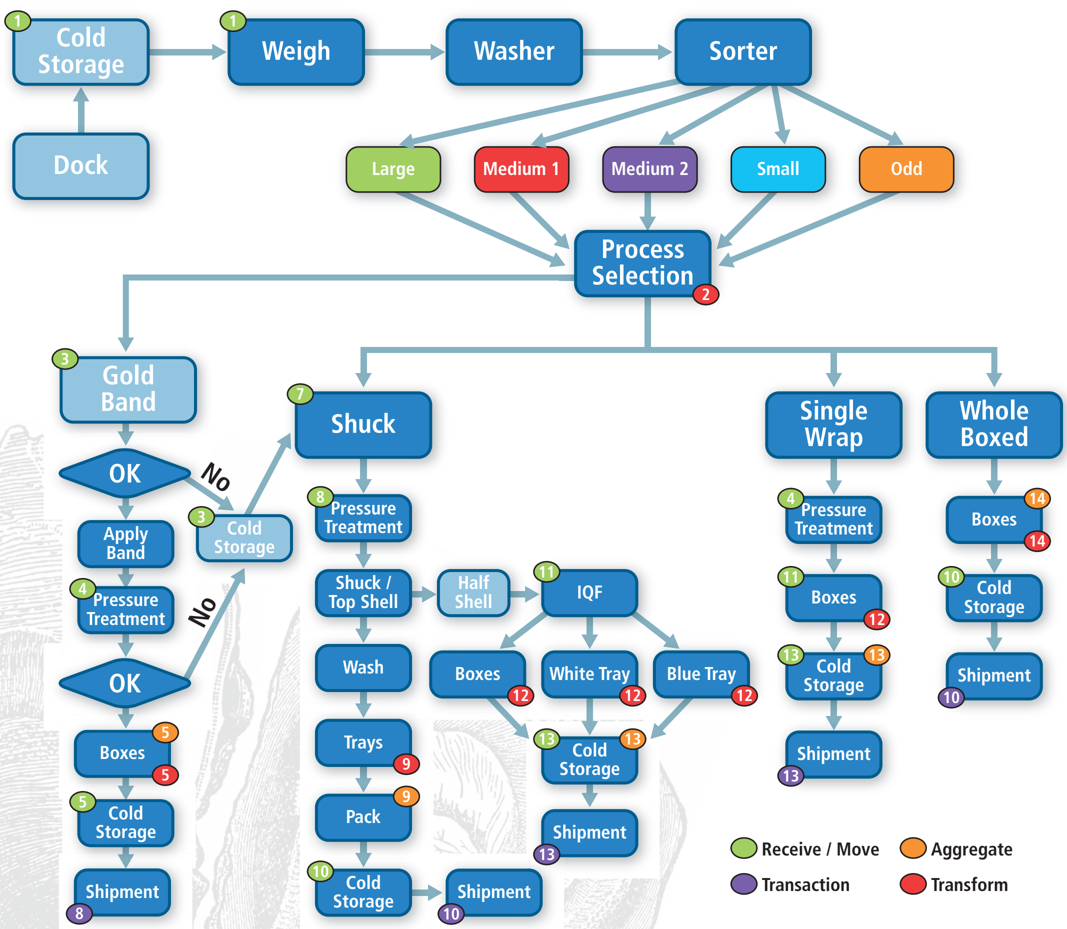



**Figure 7. Internal Operations of an Oyster Processing Plant**

Several walk-throughs and trial runs were performed during the pilot at multiple oyster processing facilities to provide a better understanding of the internal operations of oyster plants. It became clear to the pilot team that product flow was not linear and that product could be rejected in one process and subsequently moved to a secondary process.

*Lesson Learned: Product flow within oyster processing plants is not linear.*

The pilot team also observed operators using the piloted solution during the production process and identified key steps that helped to minimize the overall burden of using the digital solution. One key challenge included the correct identification of the start and stop of a lot without interrupting the flow of the production process in order to maintain full traceability. To address this issue, the pilot team designed the handheld scanning device software to aggregate and transform received tags on sacks into pallets or crates of oysters. The piloted solution also allowed for commingling to the sack tag level and smooth scanning transitions from station to station in the plant.

*Lesson Learned: Commingling of product lots must be accounted for at the product level.*

As oysters were moved through the processing plant, they were often put into crates and placed on pallets. Each of the crates or pallets had to account for the source lot numbers, which included each of the individual oyster tags that made up the current lot. Reusable QR codes were placed on each crate or pallet and, prior to the crate or pallet being loaded at the loading station, the QR code of the crate or pallet was scanned (Figure 8).

*Lesson Learned: Reusable QR codes for marking crates and pallets as product moves through a processing plant can keep track of the source lot numbers.*


**Figure 8. QR Codes for Internal Traceability**

When a crate moved to the next station, the QR Code was scanned, thereby informing the piloted software solution which oyster harvesting tags were now present at the station. Since the number and type of stations varied widely among participating pilot processing plants, the ability for the software to be configured on a business-by-business basis was essential to the success of the pilot.

*Lesson Learned: Product flow within processing facilities requires configuration on a plant-by-plant basis.*

By walking through the full processing line, the pilot team also recognized that many personnel needed to operate the software while wearing gloves. Furthermore, in an industrial environment, sound was not enough of a sensory indicator that a scan was successful, and a light sensory input was required to make it useful.

*Lesson Learned: Operators often used gloves while operating the software.*

*Lesson Learned: Sound was not enough of a sensory feedback to indicate a successful scan, and a flashing light proved to be useful.*

At some stations, high moisture content was a concern regarding the ability for the device to successfully scan the QR codes that were moving through the plant (Figure 9). Increasing the size of the QR codes eliminated the high moisture scanning problem.

*Lesson Learned: High moisture content must be accounted for, and increasing the size of the QR code eliminates scanning problems.*

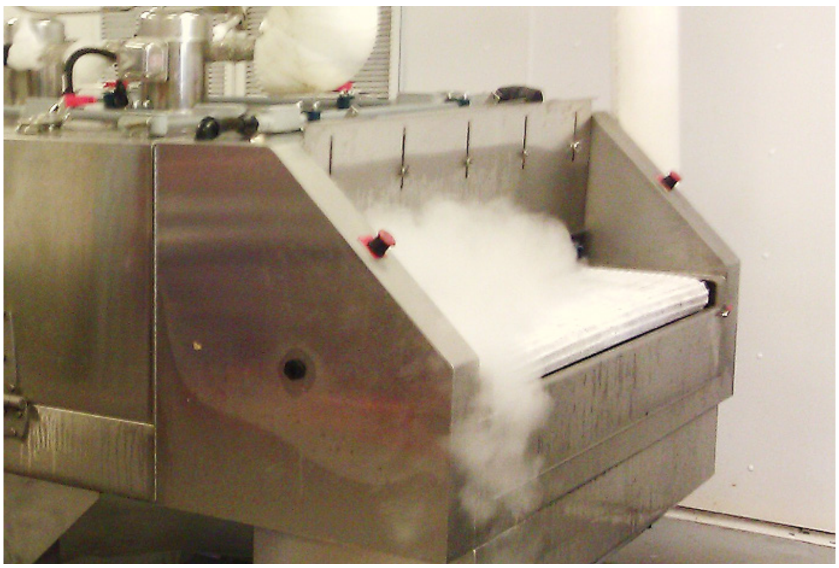


**Figure 9. A High Moisture Environment in an Oyster Processing Plant**

Operational temperature ranges between stations were also an initial concern for the pilot team. The piloted solution worked well, however, from the freezer temperature of -40$^{o}$F to the outside ambient temperature of around 100$^{o}$F.

*Lesson Learned: Large operational temperature ranges (-40$^{o}$F in the freezer to an outside temperature of 100$^{o}$F) occur in the plant and will work for a digital scanning solution.*

### Distributors and Foodservice Providers (Restaurants)

The piloted digital solution for distributors and foodservice providers was simplified as compared to the implementation at participating oyster processing plants. The key challenge for distributors and foodservice providers, however, was the cost of the hardware. The Psion Workabout Pro 3 retailed for about $1,800 at the time of the pilot, and in an effort to address this barrier, the pilot team expanded its scope to include the development of a prototype scanning software solution for a low cost smartphone. Additional detail concerning the smartphone scanning software is provided in Section 3: Hardware and Software.

The ability to accurately track which oyster tags were in production (i.e. in the kitchen) during a specific time period was found to greatly improve the tracking and tracing of oyster products. There were a number of perceived challenges, however, that included the fact that the use of a QR-coded oyster tag allowed the product to be traced back to the time and location of harvest. Some concerns were raised by the industry as to whether this level of detailed information should be available to all industry participants in the supply chain.

*Lesson Learned: The Psion Workabout Pro 3 hardware was too expensive for successful implementation for some distributors, retailers, and foodservice providers.*

*Lesson Learned: Some in the industry were concerned about how much information should be available and at what level in the supply chain.*

## 3. Hardware and Software

In addition to the QR-coded digital oyster tags, the pilot team also explored several hardware technologies related to digital hardware tagging devices, temperature recording devices, and handheld scanning devices. Various software applications were also developed or utilized; these included the digital software solution created for the handheld scanning devices, the Trace Register traceability platform, and the BlueFin electronic trip ticket system.

### A. Digital Tagging

Digital tags require a mechanism for a computer to read and record an ID from a specific product. There are several means for achieving this, and the most common are the following:

- Barcodes → Widely used in retail. See Section 2: Digital QR-Coded Oyster Tags, for information concerning the QR-coded digital oyster tags used for the pilot
- RFID→ Widely used in toll collection on toll roads
- NFC→ Starting to become widely used in cell phones and smart devices

#### Radio-Frequency Identification (RFID)

At the beginning of the pilot, RFID technology appeared to be very promising given that its ability to "auto scan" products as they moved from one area to the next area would have greatly reduced the operational cost. There were a number of key factors, however, that moved the pilot team away from RFID technology. They were as follows:

- Scanning a pallet with multiple RFID tags was not 100% accurate, as a box in the middle of the pallet may not have been recorded.

- Active RFID tags versus passive RFID tags could solve a number of problems, but the cost of an active RFID tags was too high.
- RFID hardware cost, especially for processors, was a major concern, as the large number of stations would have driven the cost too high for the pilot.
- RFID labels were available for roughly $0.11 per label at the time of the pilot and were considered too costly when compared to other technologies on the market.

### Near Field Communication (NFC)

NFC, which is increasingly available and more commonplace, was also investigated by the pilot team. An example of a NFC tag is shown in Figure 10. The NFC tag is robust and reusable and can store up to 1,000 bytes by "nearly" touching the tag to recognize it. The key challenge with the NFC tag was cost. The pilot team obtained and investigated NFC tags, and the lowest cost found was about $1.00 per tag, thereby making it too expensive for the pilot. There are many key advantages to the NFC tags, however, that include the following:

- Not affected by dirt and grime
- Reusable
- Can store large amounts of information


**Figure 10. Near Field Communication Tag**

## B. Temperature Recording

One component of the pilot was the investigation of the integration of HACCP with electronic traceability. With one of the CCPs for HACCP being temperature, the pilot team investigated how to efficiently and cost-effectively record temperature.

One device investigated was an RFID-enabled temperature recorder that had a cost from $15.00 to $20.00 per device at the time of the pilot. The intent was to place the device inside the oyster sack during transport and upload temperature readings at each station. The pilot team obtained samples of the device, but unfortunately, the company went out of business during the first half of the pilot.

The pilot team also investigated NFC temperature readers and handheld blue-tooth temperature readers. Price was also a critical barrier, and the pilot team decided to pursue the integrated VMS temperature recording approach described in Section 2: Digital QR-Coded Oyster Tags.

### C. Handheld Scanning Devices

Two handheld scanning devices were investigated during the pilot: the Psion Workabout Pro 3 and the Nokia Lumia 920. The Psion Workabout Pro 3 was utilized in the field during the duration of pilot and was the principal handheld scanning device used. The Nokia Lumia 920 was explored in an office setting toward the completion of the pilot. The handheld scanning device experiences garnered through the pilot relate to the Psion Workabout Pro 3 unless otherwise noted.

#### Psion Workabout Pro 3

The Psion Workabout Pro 3 was chosen at the beginning of the pilot and served as the only device that was used in the field (Figure 11). The Psion Workabout Pro 3 came standard with a 624 Mhz processor, 1GB of Flash, 256 MB of RAM, color touch-screen, and Bluetooth. The weight of the Psion Workabout Pro 3 was one pound without the battery. One key feature of the Psion Workabout Pro 3 was its versatility of operating in a wide variety of environmental conditions. For example, the Psion Workabout Pro 3 could function from temperatures as low as -4°F to as high as 122°F. It also had an Ingress Protection rating of 65, meaning that it could be used in the rain or in dusty conditions. The Psion Workabout Pro 3 proved to be robust and easy to use, and it functioned well in the environments tested. A key downside was the high cost of the device. Example screenshots of the software solution for the pilot, which was specifically developed for the device, are shown in Figures 12 through 16.

Figure 11. Psion Workabout Pro 3

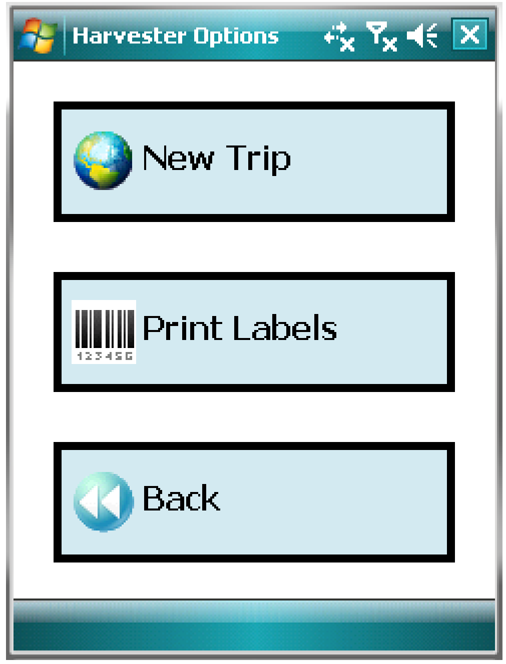



Figure 12. Harvester Options: New Trip and Print Labels

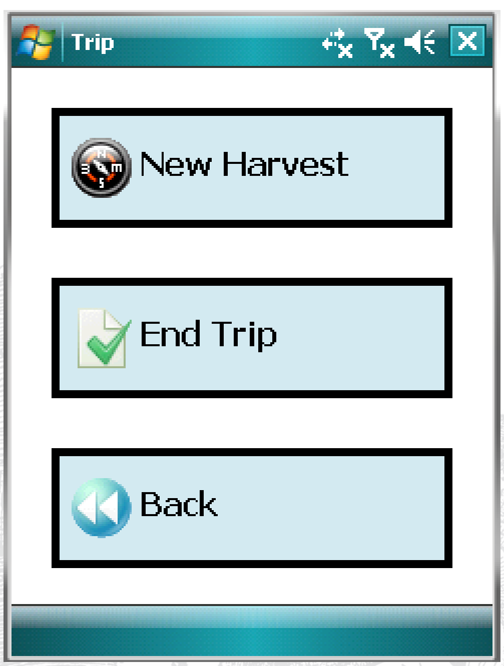



Figure 13. Harvester Options: New Harvest and End Trip

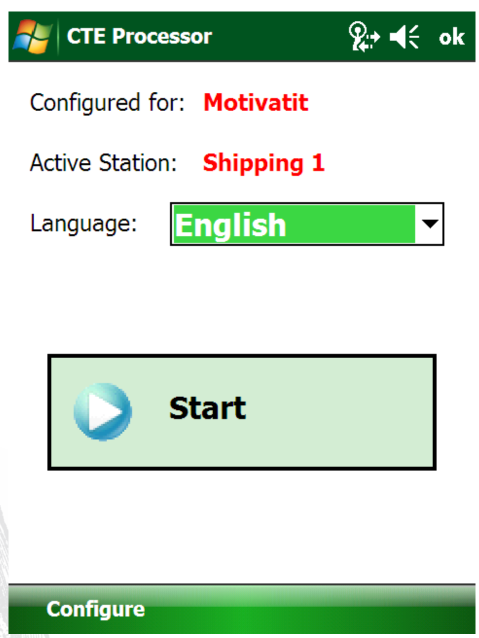



Figure 14. Processor Configuration

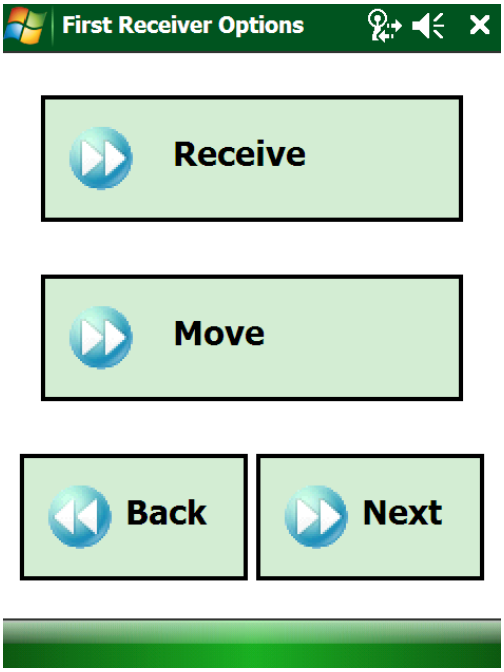



Figure 15. Dock/Dealer Options: Receive and Move

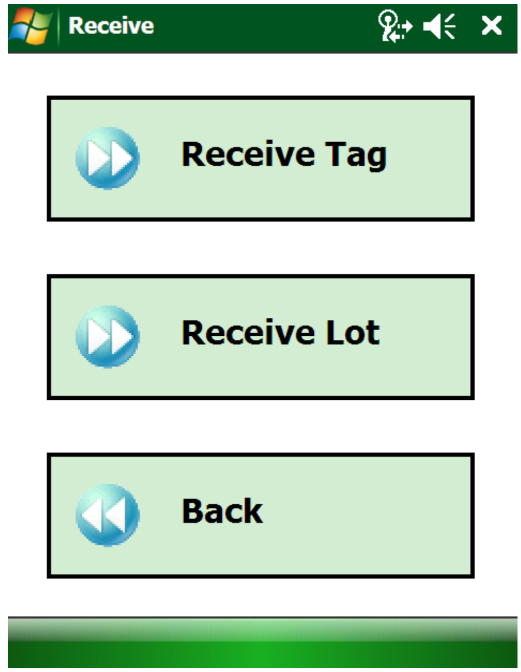



Figure 16. Receive Options

## Nokia Lumia 920

Toward the completion of the pilot, the Nokia Lumia 920 was also researched as a substitute for the Psion Workabout Pro 3 (Figure 17). The Nokia Lumia 920 was only investigated in an office setting as a viable option to future digital oyster tagging solutions; the findings presented throughout the report primarily relate to the Psion Workabout Pro 3.

Figure 17. Nokia Lumia 920 Smartphone

Smartphone devices have a major challenge, as they use a built-in camera to take a picture of the QR code and subsequently use software to interpret the QR code. Some research has indicated that there is a risk that this methodology may be adversely affected by "dirty" QR codes. In order to investigate the potential for using less expensive hardware, a software solution was developed by the pilot team for the Nokia Lumia 920 (Figures 18 through 21).

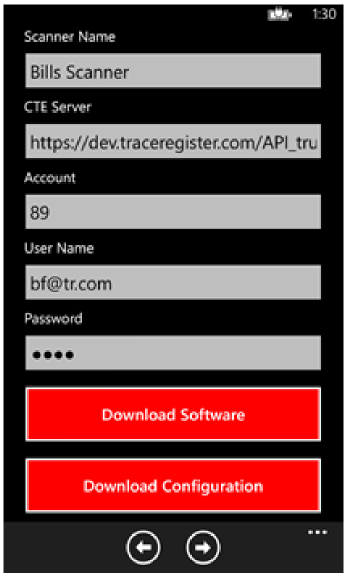



**Figure 18. Smartphone Configuration**

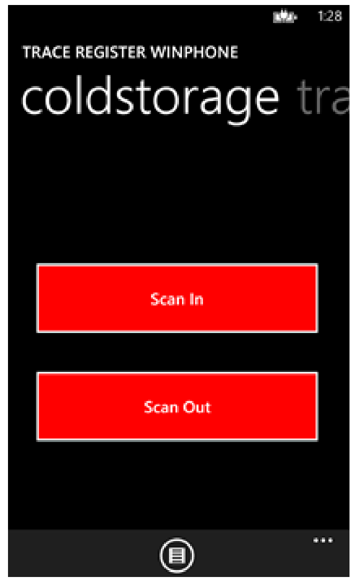



**Figure 19: Smartphone Cold Storage**

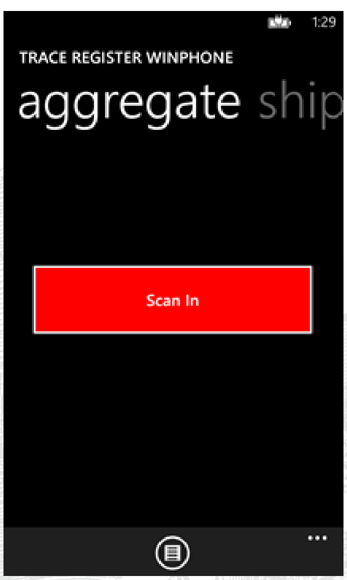



**Figure 20: Smartphone Aggregation**

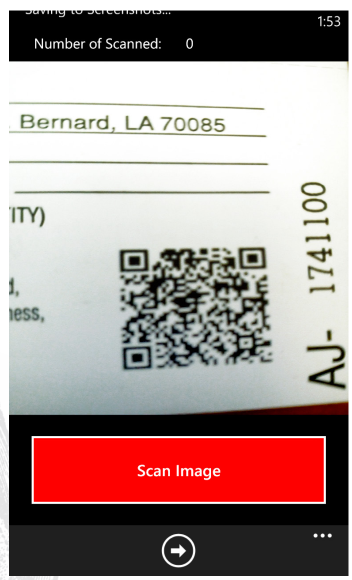



**Figure 21: Smartphone QR Code Scan**

The primary differences between Nokia Lumia 920 smartphone scanning device and the Psion Workabout Pro 3 handheld scanning device were as follows:

- Cost: The Nokia Lumia 920 was about 80% less expensive than the Psion Workabout Pro 3 device at the time of the pilot.
- Robustness: The Nokia Lumia 920 was not well suited for harsh environments and could not easily be operated while wearing gloves.
- Scanning: The Nokia Lumia 920 used image recognition software to "read" a QR code, while the Psion Workabout Pro 3 handheld scanning device used laser-based technology.

Considering the cost of the smartphone option, it was determined to be an alternative to the Psion Workabout Pro 3 for future applications. Additional research and advancements will be needed, however, to determine how to use it with gloves and to improve the scanning capability. A ruggedized case will also be needed to protect the smartphone from the harsh environment of the oyster industry.

## D. Key Challenges with Handheld Scanning Devices

The following relates to the principal handheld scanning device used for the pilot, the Psion Workabout Pro 3.

### Language Barrier

Because many users of the handheld scanning device software did not speak or read English, the pilot team developed the following two-fold solution:

1. An integrated text and pictorial harvest level interface: The pilot team added icons on all buttons beside the text at the harvest level to depict the action that an individual button handled.
2. Translation: The pilot team coded the software application to utilize translations. The application was designed to easily switch from one language to another. The languages piloted were English and Spanish.

### Existing Processes

Another challenge for the pilot team was designing the software and selecting hardware so that existing processes throughout the supply chain were not impacted, or only minimally changed. In an effort to mitigate any impact to existing processes, the pilot team designed the software to enable each location to configure the device to work within its existing process and procedures. Working with the industry, the pilot team identified additional ways to design the software to make it adaptable to the participating oyster businesses. For a majority of the time, changes to the existing production processes were not needed to fit the piloted software and hardware.

### Gloves

Gloves also presented a challenge for the pilot team, as the user interface needed to be built so someone wearing bulky gloves could effectively use it. The solution was designed such that everyday actions and tasks corresponded to large buttons that were easy to click using gloves. The integration of large buttons was an effective solution for vessel captains and processing plant personnel.

## E. Trace Register's Traceability Platform

The Trace Register traceability platform was used for the pilot as the primary software platform and online database. Trace Register is an online application used globally by over 1,000 businesses in the food industry as a method of internal and external product traceability. Based out of Seattle, Washington, Trace Register's secure servers are located both locally and remotely. Users log into their online account manually or use an XML file to upload data to a server that offers data access, security, and usability through an online portal. For the pilot, the QR code and its associated information were directly uploaded to the Trace Register server, resulting in product being shown in the user's account. Each handheld scanning device was connected to and configured for a specific Trace Register account, allowing the ability for real-time data monitoring, record keeping, and analysis. Additional descriptions of the integration of the QR code scan data and the Trace Register online application for the pilot are included throughout the report.

## F. BlueFin Data's Electronic Trip Ticket System

The electronic Trip Ticket System (TTS) was also integrated with Trace Register for CTE and KDE needs. The TTS read data from Trace Register for CTE/KDE services and created a new pre-populated trip ticket within the TTS, which allowed the TTS user to minimize the amount of data entered by hand.

To receive trip ticket data from Trace Register, the dock/dealer used the TTS as they normally would. On the TTS main screen (Figure 22), the user clicked the "find ticket" button to initiate the "find ticket" screen (Figure 23). On this screen, the user clicked the "TR Oyster Tickets" button at the top of the screen to download any new trip ticket data for the dock/dealer into the TTS from the Trace Register server.

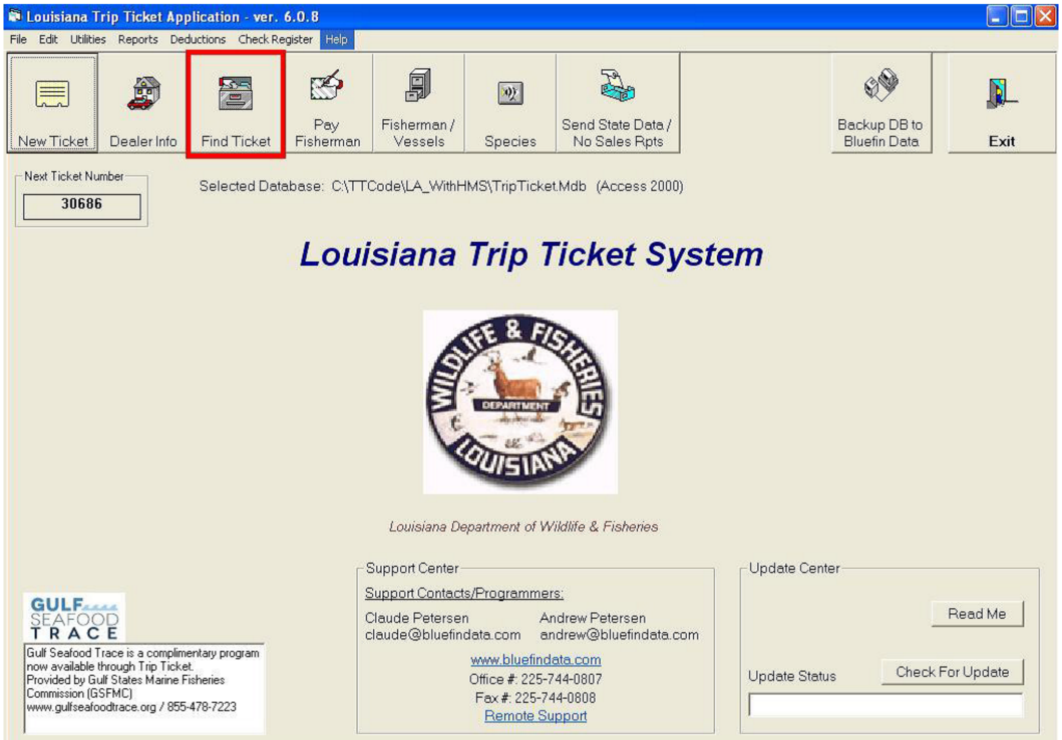



**Figure 22. Louisiana's Electronic Trip Ticket System**

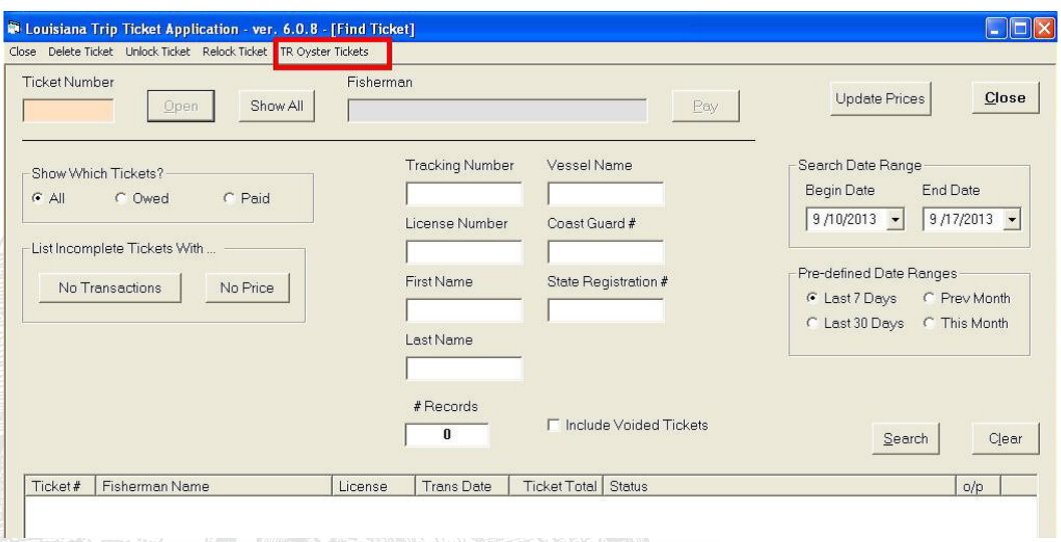



**Figure 23. The "TR Oyster Tickets" Button**

## 4. Overall Process: Critical Tracking Events (CTEs) and Key Data Elements (KDEs)

As oysters moved through the supply chain during the pilot, there were certain events that required data to be collected in order to track products internally from station to station in a facility and externally from business to business during transactions. Each of these events was referred to as a CTE. For each CTE, there were specific data that had to be recorded about the event in order to gather in-depth insight about a product. Each piece of data was referred to as a KDE, and each CTE typically had one or more KDEs associated with it. Dividing the overall process into distinct CTEs and KDEs enabled a modular solution, thereby maintaining digital traceability. A modular solution dramatically reduced the complexity and fragility of the overall solution.

### A. Critical Tracking Events (CTEs)

A CTE is similar to a HACCP CCP and was defined as any event that required data collection in order to track products through an event. The CTE represented a message attached to a product, and each CTE had a specific set of header fields associated with it. These fields included entity, product ID, date and time stamp, location ID, and the name of the CTE. In addition, each CTE typically had a set of associated KDEs. Examples of KDEs were location of harvest, species information, temperature, input products for aggregation and transformation, new location ID for a move, and product count for an inventory CTE.

#### Definitions for CTEs

The following CTEs were defined for the pilot:

*Creation*

The creation event represented the first CTE event for a product and was most commonly used at the harvest level.

*Aggregation*

Aggregation consisted of grouping many products into one larger product. Doing so allowed the user to scan product from one station or participating business to another with fewer scans per quantity of product while still keeping the same level of traceability. The most common application of an aggregation occurred when product was placed on pallets. Once an aggregation was performed, the user had the option to take the aggregated pallet apart into smaller pieces. Each new aggregation received a new ID with links to the aggregated products, which resulted in the creation of a pallet license plate containing the new ID.

### *Transformation*

Transformation of a product consisted of changing one or more different products into a new product. The transformation function was often the most critical CTE in a processing plant and was key to maintaining the traceability of the product. The main difference between an aggregation event and a transformation event was that an aggregation event could be undone, whereas a transformation event could not be undone. Furthermore, after a transformation event, the input ID for the product could not appear again in the supply chain.

### *Business Transaction*

A business transaction represented a change of ownership of product and triggered a trace document to be sent through the system. A trace document, short for traceability document in Trace Register, contained all pertinent information that the supplier authorized the buyer to see. This event was unique in that it created an indirect break in the information flow and represented the exchange between internal traceability and external traceability.

### Delivering/Sending

When a product was ready to be shipped, the "deliver" CTE was selected, and an option to choose the buyer of the product appeared in a dropdown list. The buyer options were connected to the participating business accounts in Trace Register, and once the product was selected, the buyer was chosen, and the "deliver" option was selected. The product was subsequently sent through the system, reflecting a decrease in inventory.

### Receiving

On the receiving end of a shipment for a participating business, the first action on the handheld scanning device was to "receive" the product. This CTE captured that the product was in a business's possession and had the ability to go through any of the CTEs at other stations within that business before being sent again, reflecting an increase in inventory.

### *Moving*

A move represented a change of location of a product. The move CTE was most often used when relocating product from the production floor in a processing plant to cold storage. As this happened often and was integral to record the CTE, the pilot team programmed the move CTE function on certain handheld scanning devices to simply read "cold storage" in order to make it easier for users on the production floor.

*Depletion*

A depletion represented lost product, or a change in the count of one or more products on hand, and signified a loss of inventory.

*Disposal*

A disposal event represented the destruction of a product. The product should not have appeared in the supply chain after the disposal event had been recorded.

## CTEs Implemented

All participating businesses, and handheld scanning device stations within a business, had the ability to have their CTEs customized at any time. During the pilot, however, the following primary CTEs were implemented for the respective components of the supply chain:

*Vessel*

*<u>Creation and Delivering</u>*

The vessel's handheld scanning devices were programmed for the harvest area and the tag color (white, green, or pink) prior to scanning oyster tags at the time of harvest. Once these KDEs were selected, tags were scanned for the current lot and logged in the handheld scanning device. Over the course of a trip, the vessel could scan multiple harvests and lots, which were stored on the handheld scanning device. If the trip lasted for multiple days, spanned multiple areas, and contained many lots, the handheld scanning device was able to store and separate all of the data accordingly. When the vessel returned to the dock/dealer and the handheld device connected to a Wi-Fi transmitter, the trip information was delivered to the buyer (dock/dealer facility or processing plant), as selected from the dropdown list via the "deliver" option. At this point, the harvesting vessel's scanning responsibilities were completed.

*Dock/Dealer*

*<u>Receiving, Transformation, Aggregation, and Delivering</u>*

When harvesters offloaded oysters from the vessel, the product was typically loaded straight onto a truck destined for a processing plant. The truck was typically owned by the processing plant and, in many cases, acted as the dock/dealer by selecting "receive" on the handheld scanning device. Each tag was scanned by the handheld device as it was coming off the conveyor belt, and the product was subsequently placed on a pallet prior to being loaded on a truck. When all of the tags had been scanned, the truck driver clicked "finish" to end his/her scanning responsibilities. The business transaction was therefore completed and shown in the processor's Trace Register account. During the pilot, this sequence occurred for the Motivatit Seafoods and Crystal Seas Oysters participating supply chains.

For Crystal Seas Oysters, the truck handheld scanning device was connected to the Crystal Seas Oysters processor's Trace Register account. At Motivatit Seafoods, the truck acted as a dock/dealer, and after the product was received, it was delivered to Motivatit Seafoods (the processor) with a single click. Motivatit Seafoods subsequently received the product as the product entered the processing facility. This process demonstrated the capability of the handheld scanning solution to handle a situation in which product was brought to a separate dock/dealer upon offload and was distributed to multiple processors or other buyers. While this was not the case in the pilot, the pilot team felt it was important to demonstrate that this situation was possible, as it is often the case for many oyster vessel offload sites in Louisiana and the other Gulf States.

### *Processing Plant*

*Receiving, Moving, Transformation, Aggregation, and Delivering*

As product was received at the processing plant, it took one of many different paths through production before it was ready to be sold and shipped. The paths oysters took through production were either simple, such as when oysters were received and delivered using mini-sacks as they came off the vessel, or extremely complex. In a complex operation, oysters were washed and screened for quality, separated, and processed into Individually Quick-Frozen (IQF) oysters on the halfshell, tubs of oyster meat, or high pressure-treated, boxed oysters in the shell. Given the variance and unpredictability of an oyster's journey through the plant and out the door, the handheld scanning device software needed to handle transformations, aggregations, and moves at all stations in a processing plant and account for all situations.

As a result, handheld scanning devices were located at every station where a CTE needed to be recorded throughout the processing plant. These represented points where product had the greatest potential to lose its traceability. A typical processing plant may only receive and deliver product but not have any other CTEs. In this case, it may only have two handheld scanning devices, one for incoming and one for outgoing product. For one of the processing plants participating in the pilot, however, each station where product was transformed (i.e. wash, shuck, meat room, box room, IQF room) was programmed with a "transformation", "aggregation", and a "move" CTE as the first options. For purposes of recording times at which product was sent to cold storage for processing at a later time, the handheld scanning device was programmed with a "cold storage" move CTE. The details of the handheld scanning device CTE configurations at each station at Motivatit Seafoods and Crystal Seas Oysters are discussed in Section 5: Industry Participants.

*Distributor*

*Receiving, Moving, Aggregation, Transformation, and Delivering*

At the distributor level, the pilot team implemented the same CTEs as at the processing plant; however, the internal process was simpler. There were a few, if any, instances in which a transformation occurred in the distribution warehouse. Most of the CTEs, other than receiving and delivering, were moving or aggregation. Delivering was perhaps the most important CTE at the distributor level. For example, in a recall, it is imperative to know where the product in question was sent to. As a distributor will often utilize a large lot and break it out to many different buyers, their most important CTE consisted of how they separated and shipped their product.

*Foodservice Provider (Restaurant)*

*Receiving and Moving*

At the restaurant level, personnel scanned the product with the handheld device as the product came in the back door, clicked "receive," and selected "move" when the product was moved to cold storage. When product was ready to be sold, a "move" was selected to indicate that the product was at the point of sale for the consumer. At this point, vessel-to-plate traceability had been completed.

## B. Key Data Elements (KDEs)

The following, which corresponds to the aforementioned CTEs, provides a description of the primary KDEs that were utilized for the pilot:

### Location of Harvest

The location of the harvest was selected on the handheld scanning device by the user on the vessel before harvest occurred. When the harvest CTE was created by the pilot team, all Louisiana fishing areas were programmed as selectable options in the area dropdown menu. In addition, the timestamp of the CTEs could be utilized to link the VMS location transmission to obtain a latitude and longitude of the vessel at the time of a scan. This had the ability to act as verification that the vessel was in the selected area when oysters were harvested and tags were applied to sacks.

### Time of Harvest (Part of the CTE Header)

The time of harvest was recorded on the harvester handheld scanning device through a timestamp of the CTE harvest scan. After the area and tag color were selected, each tag that was a part of that harvest was scanned either prior to or as the tags were put on the oyster sacks. The timestamp on the CTE corresponded to the time that each QR code was scanned.

### Timestamps of CTEs (Part of the CTE Header)

Besides at the point of harvest, it was important to record the times that other CTEs occurred as oysters made their way to the plate. Each CTE had a timestamp that allowed the time of each business transaction to be recorded and uploaded as a KDE in Trace Register. This action documented the duration that each participating business held the product.

Beyond business transactions, it was also important to record timestamps for CTEs that occurred internally for each participating business. For instance, it was determined useful for processors to know how long oysters were held at a particular station. With CTEs timestamps recorded for either end of each station's process, processors could analyze their production floor operations to identify any inefficiencies.

Another important CTE timestamp that was implemented was a cold storage move. At the processor, distributor, or restaurant, it was useful to know the time when a product was placed in cold storage or removed. With this capability, the system could provide data on how long products were chilled or how long products were in a truck en route to cold storage. At a restaurant, the cold storage move timestamp documented the time when the product reached the point of sale, thus increasing the precision of traceability at the consumer level.

### Species Information

For the pilot, the Eastern Oyster (*Crassostrea virginica)* was the only species handled and was the only option programmed into the species dropdown list within the software for the handheld scanning devices. The software could have easily incorporated additional species on the dropdown menu if desired.

### Temperature: Merger of Critical Tracking Events (CTEs) and Critical Control Points (CCPs)

CTEs are strictly meant to handle the traceability of a product, while HACCP is a methodology designed to ensure quality, safety, and compliance of a product through non-destructive testing. An integral part of HACCP is the concept of a CCP. A CCP is somewhat similar to a CTE but serves a different purpose. During the pilot, it became clear that an internal system that merges the CTEs and CCPs was needed.

Temperature recording, as the product moves through the supply chain, is a key CCP required by various regulations. Location and time must also be recorded in conjunction with oyster temperature. Some regulations require that the temperature of the oyster meat is measured and recorded, while other regulations specify requirements of cooler temperatures onboard the vessel. For the pilot, temperature was only collected at the vessel through the integrated VMS and digital tagging solution. Extending the piloted internal traceability solution to include additional CCPs could potentially provide significant efficiency gains.

## 5. Industry Participants

### Motivatit Seafoods

Motivatit Seafoods is a multigenerational family business located in Houma, Louisiana. Founded in 1971, it has become a leader in oyster harvesting, processing, and fresh and frozen distribution.

#### Implementation Details

*Training/Process Flow*

At Motivatit Seafoods, the pilot team deployed and trained personnel on 14 handheld scanning devices. Two handheld scanning devices were used for vessels, two were used for delivery trucks, and 10 were used for various locations in the processing plant. The handheld scanning devices were deployed in the processing plant at the following stations:

- Receiving
- Wash Room
- Shuck Room
- Meat Room
- IQF Room
- Plant 2 Gold Band Room
- Plant 2 Box Room
- Delivering

The process flow through the Motivatit Seafoods plant was complex, with CTE types configured each time there was a chance that the traceability may have been lost. For each type of oyster produced in the plant, the handheld scanning device software was capable of tracking a tag or group of tags through the facility, thus demonstrating the ability of the scanner software to track product through a variety of complex processes. Three different buyers were programmed into the shipping handheld scanning device at Motivatit Seafoods, where one buyer, New Orleans Fish House, had a scanner of its own.

#### Pilot Findings

Training at the Motivatit Seafoods processing plant on the handheld scanning devices and the digital tag scanning process was simple and straightforward. Both English- and Spanish-speaking personnel at each of the processing plant stations quickly learned how to use the hardware and software and the respective actions required to effectively scan and transmit data. Many of the personnel on the processing plant floor were excited to try something new, outside of their daily routine. When the handheld scanning device was somewhat intimidating to use, the prospect of a change of pace helped to facilitate their enthusiasm.

The piloted digital traceability process, when running consistently, was not a burden to production flow at Motivatit Seafoods, even when run in conjunction with the current manual traceability process. In comparing the scanning solution piloted at Motivatit Seafoods and the current manual tracking system, increased efficiency was the most attractive benefit observed from a production cost standpoint.

The handheld device scanning system at Motivatit Seafoods increased the precision and accuracy in determining the origin of any lot in production. While the manual system typically tracked and recorded the date and harvest area, it was shown that the handheld device scanning system could also easily record additional data such as the vessel, harvest area, date, time, and, if needed, the refrigeration temperature at the time of harvest. As the scans were performed for each CTE, there was less room for manual error in either product separation or commingling. Having the CTE handheld scanning device data digitally accessible, rather than a handwritten manual transfer of the KDEs, added accountability to the entire process.

**Crystal Seas Oysters**

Located in Pass Christian, Mississippi, Crystal Seas Oysters is a family-run business. The company owns various private oyster reefs, runs oyster vessels, operates buying docks in Mississippi and Louisiana, and runs an oyster processing plant.

### Implementation Details

*Training/Process Flow*

A simplified approach was implemented by the pilot team for Crystal Seas Oysters. Oysters from designated supply vessels run by Cajun Shellfish in Louisiana were held in “mini-sacks.” These smaller sacks were harvested in Louisiana waters, trucked to Crystal Seas Oysters in Mississippi, stored overnight at the processing plant, and shipped out the next morning to distributors and restaurants. The mini-sack oysters were not processed and went directly to distributors and restaurants in the same sack that they were put into at harvest. The pilot team programmed ten different buyers into the Crystal Seas Oysters delivery handheld scanning device. Two of these buyers, New Orleans Fish House and Half Shell Oyster House-Biloxi, each had handheld scanning devices to receive delivered product.

With incoming harvests of 500 or more mini-sacks over multi-day trips from different areas, the distribution resulted in commingled pallets of mini-sacks. A digital handheld device scanning system allowed for real-time tracking of where each sack was sold. In the event of a recall, anyone monitoring the scanning data in Trace Register could have immediately known how many mini-sacks for a particular day were sold and which geographic areas they were from. This solution also allowed restaurants to scan at the point of sale to identify which consumer plates the oysters from each mini-sack corresponded to. Mini-sack distribution, combined with digital handheld device scanning throughout the supply chain, resulted in the most effective method of traceability with regard to risk management.

### Pilot Findings

Crystal Seas Oysters used handheld scanning devices to scan each tag with a QR code that came into the plant and subsequently delivered the tags to each of the buyers programmed in the scanner. The training was straightforward, and personnel caught on quickly to the technology. Having the plant manager supervise the handheld device scanning process helped with implementation. In addition to having a designated production floor representative responsible for ensuring that the scanning took place, having a handheld scanning device supervisor, or facilitator, helped when personnel had questions.

## Cajun Shellfish

Cajun Shellfish is a supplier to Crystal Seas Oysters and owns a fleet of vessels based out of Hopedale, Louisiana.

### Training/Process Flow

Given the seven vessels that comprise the Cajun Shellfish fleet, oyster tag scanning was initially implemented on a vessel that often went oyster harvesting for two to three days at a time and was referred to as Boat One. This vessel was chosen as a result of the willingness of the captain to try something new and the state-of-the-art refrigeration system onboard. Boat One typically landed 500 or more mini-sacks from one trip and was an excellent candidate to pilot the scanning software and hardware capabilities.

The captain and first mate of Boat One were easily trained and were willing participants when the handheld scanning devices were deployed. Unfortunately, Boat One suffered major engine complications and had to be hauled out of the water before scanning was accomplished. As a backup vessel, the pilot team implemented a handheld scanning device on Boat Two, where, unfortunately, scanning data was not routinely available.

## Half Shell Oyster House-Biloxi

The Halfshell Oyster House-Biloxi is a restaurant located in Biloxi, Mississippi. Opened in 2011, the restaurant is known for its assortment of raw and open flame cooked oysters. There are additional Halfshell Oyster House locations in Gulfport, Mississippi; Hattiesburg, Mississippi; and Sarasota, Florida.

### Training/Process Flow

At the Half Shell Oyster House-Biloxi, the pilot team implemented a handheld scanning device to receive and scan all incoming sacks from Crystal Seas Oysters when a QR code was located on a tag. Training was also provided so that tag scanning could take place when a sack was removed from the cooler and prepared for the consumer at the point of sale. This action created true vessel to plate traceability; however, the restaurant decided to only scan at the reception of the product. Training and implementation was a smooth and simple process with eager participants.

### New Orleans Fish House

New Orleans Fish House is a processing and distribution facility that offers seafood products to customers in Louisiana, Mississippi, and the Florida panhandle.

### Training/Process Flow

A handheld scanning device was configured for New Orleans Fish House to receive either pallets of oysters from Motivatit Seafoods or mini-sacks from Crystal Seas Oysters. Training for use of the handheld scanning device by New Orleans Fish House was efficient and straightforward. The handheld scanning device was set up to deliver tag and scanning data to a number of restaurants in the New Orleans, Louisiana area. These locations were not trained to scan incoming product and did not utilize a handheld scanning device.

## 6. Trial Recall

With data uploaded to Trace Register, the pilot team chose a random oyster product from a participating business and used the system to trace it from the restaurant back to the source. The pilot team also tracked the sourced product from the identified areas for specific days to identify additional locations where it was being held or sold. It should be noted that each participating business provided the appropriate data visibility and authorizations for the trial recall to take place.

The steps taken to accomplish the trial recall as part of the pilot were as follows:

Step 1: Product was identified by lot number and in Trace Register for the account of the establishment in question. The establishment for the trial recall was identified as Big Al's Seafood Restaurant in Houma, Louisiana.

Step 2: After the product was identified in Trace Register, the "trace product" button was clicked.

Step 3: By clicking the green pinpoints for each vessel, the pilot team was able to identify the area from which the product originated. For each pinpoint, "more info" was clicked to reveal the lot number, harvest area, and harvest date. For the trial recall, the product was identified as having been harvested by a vessel called Boat Two on 7/23/13 from Areas 26 and 27 (Figure 24 and Figure 25).

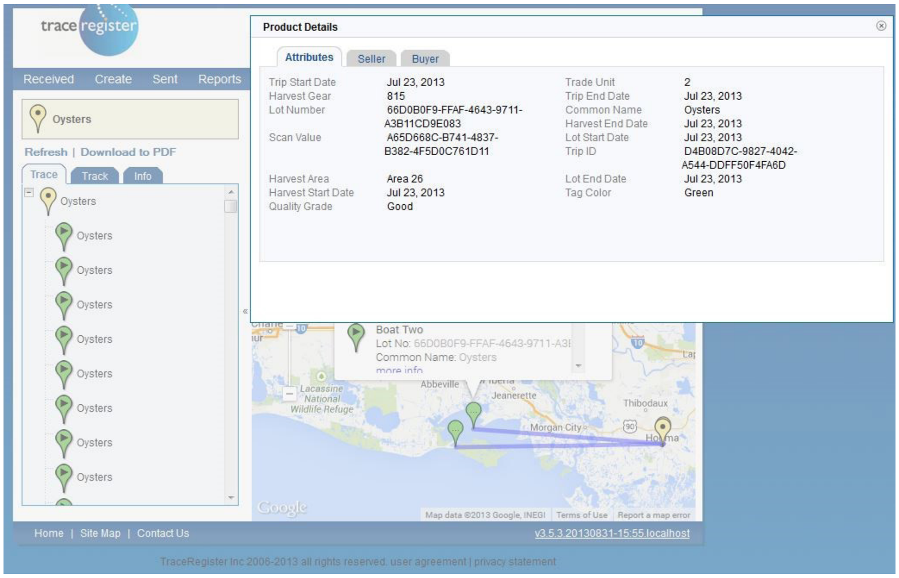



**Figure 24. Tracing Product from a Restaurant for Area 26**

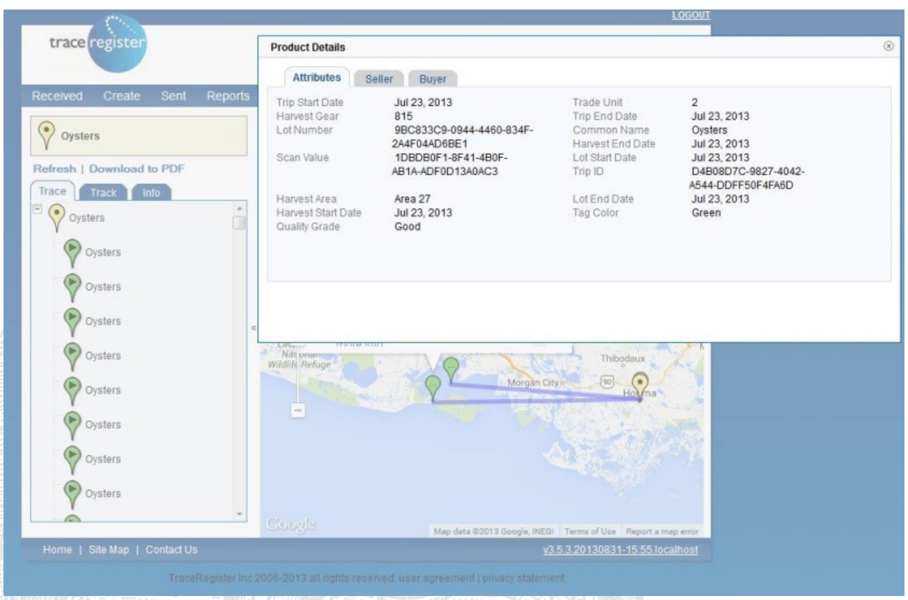



**Figure 25. Tracing Product from a Restaurant for Area 27**

Step 4: The Trace Register account for Boat Two was selected, and the sent products for the lot numbers in question were searched. The lot numbers in question for the trial recall ended in A3B11CD9E083 and 2A4F04AD6BE1 (Figures 26 and 27).

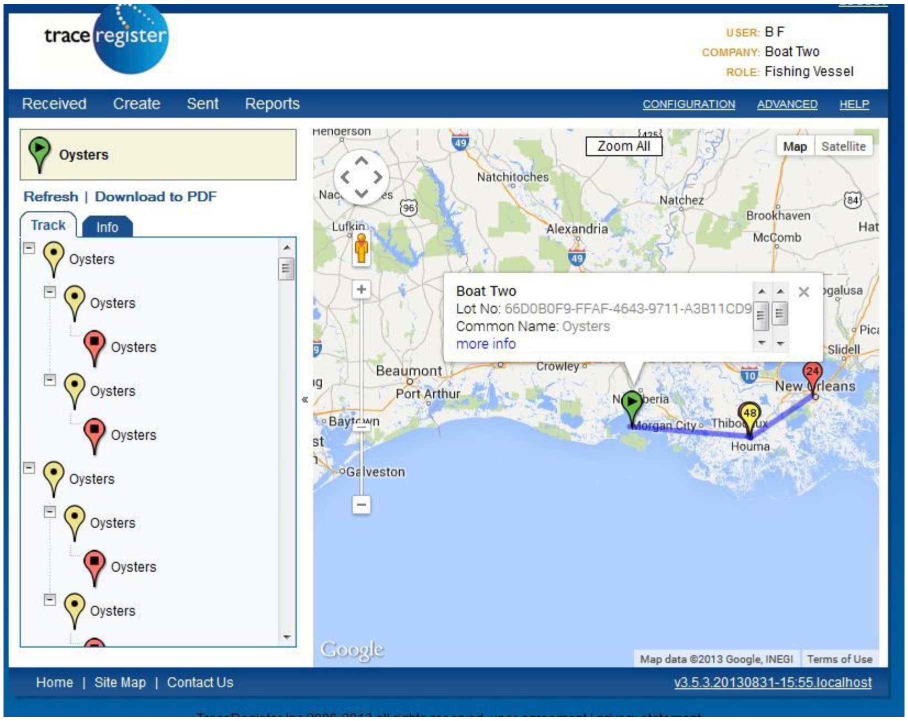



Figure 26. Tracking Product in a Vessel Account for the Lot Ending in A3B11CD9E083

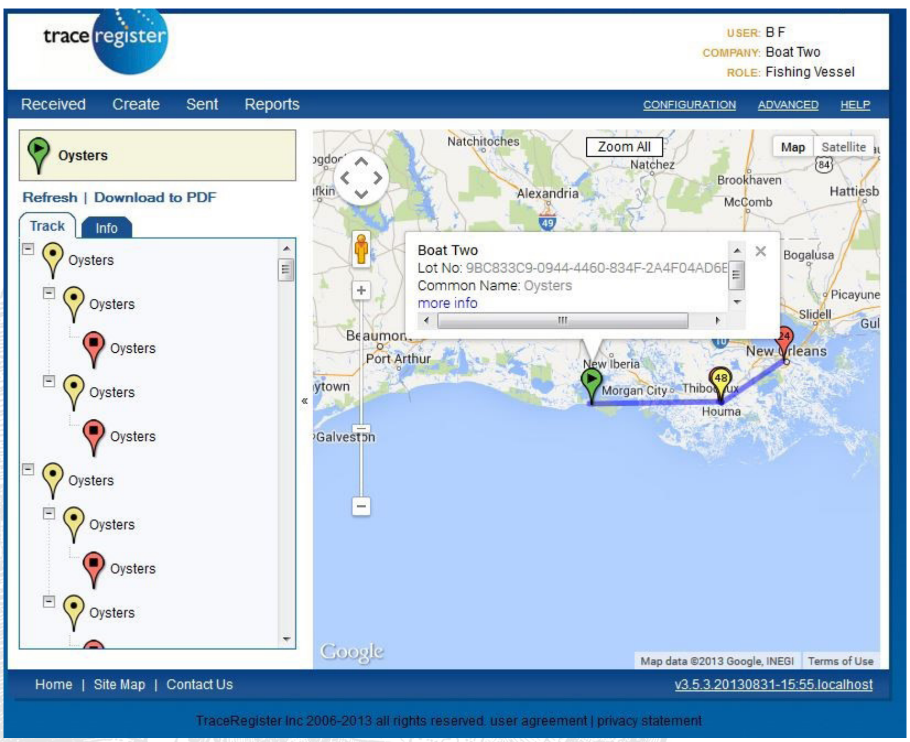



Figure 27. Tracking Product in a Vessel Account for the Lot Ending in 2A4F04AD6BE1

Step 5: “Trace product” was clicked in order for the “trace” and “track” tabs to be opened. For the vessel’s Trace Register account, “track” was only available, as this was the beginning of the supply chain.

Step 6: The pilot team clicked each red pinpoint to reveal the current location of the product in question for the trial recall as it related to the entirety of the product for the identified lot. For the trial recall, it was identified that, in addition to Big Al’s Seafood Restaurant, a large portion of the product was also received by New Orleans Fish House (Figure 28).

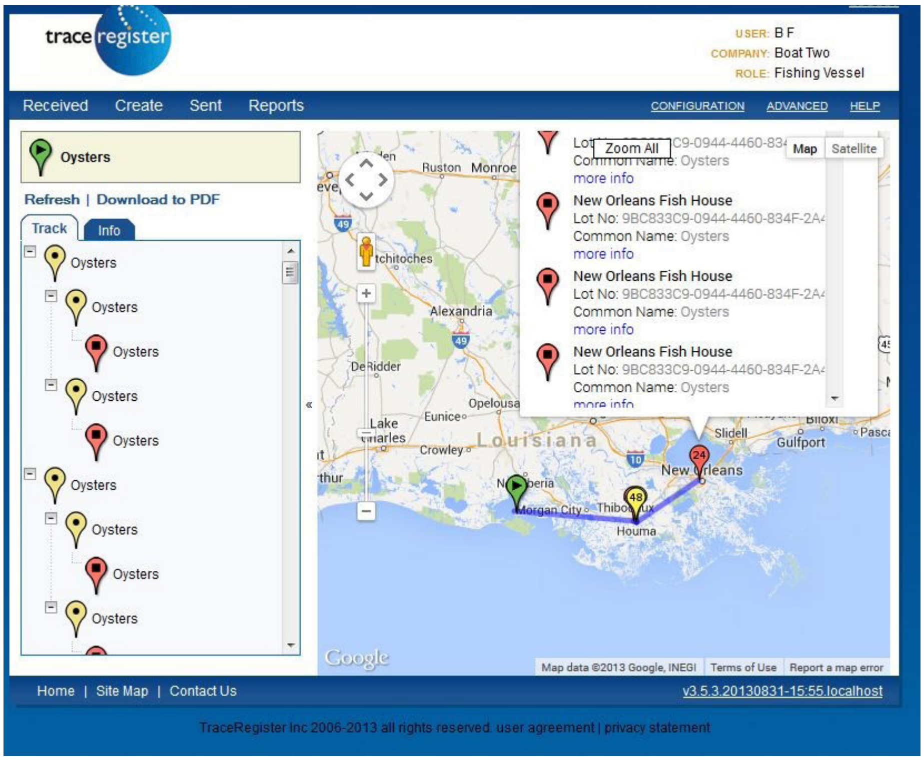



**Figure 28. End Product Locations for the Trial Recall: Big Al’s Seafood Restaurant and New Orleans Fish House**

If this had been an actual recall, Big Al’s Seafood Restaurant and New Orleans Fish House could have been easily notified before the product could have been a risk to additional consumers. In an ideal situation, the entire recall process should take fewer than ten minutes if access and approvals are granted to the appropriate Trace Register accounts.

## 7. Findings and Challenges

### Key Findings

The following key findings were identified throughout the pilot:

- The pilot demonstrated that digital oyster tag scanning with a handheld device can be used to capture supply chain information in a secure manner.
- The pilot showed that the handheld scanning device must be able to function in a disconnected mode and subsequently update the server when an internet connection becomes available.
- The software functionality for the handheld scanning device was simple and easily grasped by personnel in all participating businesses throughout the supply chain.
- The handheld scanning devices investigated during the pilot met the requirements regarding reliability and functionality; however, the relatively high cost of the Psion Workabout Pro 3 may be an obstacle.
- Implementation and deployment of handheld device scanning at the vessel and at the delivery truck level showed that full implementation may result in too many items to scan. The utilization of aggregated batch tags, such as license plates, could significantly reduce the number of scans without reducing the level of traceability.
- Internet connectivity using Wi-Fi transmitters in remote areas has some unique challenges, specifically with regard to security and availability.
- The Trace Register web interface proved to be an effective method of tracing product back to the source and tracking product forward in the event of a recall.
- The pilot showed that information from a digital oyster supply chain can be used by the oyster industry to significantly increase levels of accountability, safety, and confidence.

## What Worked

### Digital Tags

The manufacturing, distribution, cost, and use of the digital QR-coded tags, with the exception of the handheld devices, added only a minor direct cost for participants of the pilot. The tags proved to be resilient to the harsh conditions of the oyster supply chain from the vessel to the processing plant, distributor, and restaurant. The application and general use of digital QR-coded tags proved to be similar to the current tagging process. Essentially, the pilot team ran the pilot using two tracking methods running in parallel: the manual handwritten method and the digital QR code scanning method. The capability of the digital tags to function within the same workflow speaks to their versatility and practicality.

### Hardware

The Psion Workabout Pro 3, the primary handheld scanning device used for the pilot, met all of the expectations during the pilot in terms of durability and functionality. The device was dropped and exposed to water during daily use in a processing plant. Oyster processing produces a considerable amount of debris from oyster shells, so functionality in the face of harsh environmental conditions was essential, and the Psion Workabout Pro 3 performed particularly well. The basic functions of the device, which included on/off, checking the battery, and general navigation, were easily learned by personnel at all levels. The Psion Workabout Pro 3 connected easily to a Wi-Fi transmitter and stored any previous connections to prevent re-entering Wi-Fi transmitter passwords. The touch screen was responsive to clicks and was especially easy to operate when using the attached stylus. While increasing the handheld scanning device audio did not communicate the scanning process effectively, additional sensory feedback such as the use of the flashing light on the device was needed to allow a user to move through a group of QR code scans efficiently. In summary, the Psion Workabout Pro 3 handheld scanning device was adequate in every way, especially in terms of durability.

### Software

The Trace Register scanner software application, developed for the handheld scanning devices, was a simple program, built to be flexible and customizable to any role in the supply chain. The touch screen buttons were designed to be big enough to be accurately touched with large gloves or the provided small pen attachment on the Psion Workabout Pro 3. The transitions from screen to screen were smooth and straightforward. The English/Spanish language option was strategically placed on the handheld scanning device homepage so that it was easy to find and could be changed if needed.

Being able to customize the order of CTEs on each handheld scanning device was also important, as each station or participating business would usually only use one or two functions. This customization provided a user-friendly interface in which the CTEs could be placed at the beginning of the list. The download configuration and download software options on the "configure" screen also allowed for flexibility and on-the-fly changes to an individual handheld scanning device. The changes were also capable of being made remotely, so the impact on the user was minimal when updates needed to be made.

### Overall Process

The flexibility of the handheld device scanning software, durability of the Psion Workabout Pro 3, and the ease of use of all elements led to the overall success of the pilot. Because the structure of the pilot and the software were essentially being tested to their capacity, the ability to change things at a moment's notice was imperative. With each station and each participating business having different needs at different times, the ability to customize each handheld scanning device's user interface and functionality allowed for the pilot team to make it easy for users at each stage of the supply chain. The pilot team's confidence in the equipment to withstand the physical strains of the oyster industry also led to the overall success of the pilot.

The digital scanning process worked for both small and large companies, which was a requirement for the pilot. The scanning system also created an efficient and precise traceability component for businesses even if the harvesters did not participate. If the harvester did not participate, the processor could enter the harvest area and date information at the time of reception and continue scanning normally. The received tags would also not necessarily require QR codes to be printed on them, as the processor could use a label representing the aggregated products, or a license plate tag, on new pallets.

The pilot was designed to adapt to the existing oyster tracking process, thereby simply improving upon the manual process by implementing a time-saving and accessible digital system. The digital scanning design led to a successful pilot, as there were no attempts to add new concepts or implement drastic logistical changes. The pilot simply changed the method by which the current system records and stores data. While the digital scanning technology may be new to users in the oyster industry, the operational process remained the same, leading to a high likelihood of a successful implementation in the future.

**Key Challenges**

Digital Tags

The most challenging aspect of the QR-coded digital tags was what to do in the event that a tag was lost or damaged or would not scan. Having a missing tag is an existing issue that the current manual system contends with. As the tags in the pilot were attached in the same way, and the focus of the pilot was to develop the digital scanning solution, the pilot team did not implement a new solution to missing tags or tags falling off of sacks. However, the pilot team did explore the concept of a replacement tag solution in which data from a tag from the same lot could be transferred to a new tag that does not have any information tied to it.

During the pilot, oyster tags often became muddy or dirty while being moved from vessels to trucks or at any point inside the processing plant. This issue was a minor one, as the tags were able to be scanned again when the mud was cleaned off.

Occasionally, tags became scraped by an adjacent pallet, smudging the print and leaving the tag unable to be scanned. Similar to a missing tag, the replacement tag function explored by the pilot team could also solve the smudged tag issue.

Hardware

The Psion Workabout Pro 3, the principal handheld scanning device for the pilot, generally worked well for the pilot but included a few shortcomings. For certain stations in the supply chain, the weight, size, cost, and number of buttons and functions were intimidating to personnel who were accustomed to a specific routine and familiar equipment. The implications of a new task with unfamiliar equipment were an unwanted burden for some personnel.

Wi-Fi transmitter signal connectivity also presented a challenge for the Psion Workabout Pro 3 and the pilot team. While the handheld scanning devices were successful at connecting to a Wi-Fi transmitter signal up to 100 feet away, finding a good Wi-Fi transmitter signal in a remote area, where the docks/dealers were typically located, was often a problem. To remedy the problem, the pilot team installed a Wi-Fi transmitter using a cellular signal to broadcast the Wi-Fi. The Wi-Fi transmitter itself was a viable solution as long as a waterproof electrical source, and a way to lock and waterproof the device, could be found. The devices themselves transmitted well, and the connectivity was good upon implementation, but the longevity of high quality Wi-Fi broadcast was an issue as a result of security. In one instance, a Wi-Fi transmitter was stolen from a locked security box.

## Software

Fortunately, the pilot only incurred a few instances in which time-consuming software troubleshooting for the handheld scanning devices was required. In general, the software that was developed and used for the pilot proved to be easy to use for personnel. From time to time, the “deliver” transmission would not connect to the Trace Register servers (as a result of connectivity problems) and would not show as delivered. In these instances, the handheld scanning device start screen showed the “upload” option, a notification to the user that the last transmission was not completed. This option prompted the user to try to upload the data again when the connection improved.

## Overall Process

The piloted solution of scanning digital QR-coded oyster tags proved to be a more efficient and robust traceability system than the manual tag trading system that the oyster industry currently has in place. As the pilot ran in parallel to existing operations, it relied on participants engaging in additional work. It was, therefore, challenging to produce a constant stream of data that flowed from business to business. While all of the pilot participants were willing, capable, and supportive of the pilot, they viewed the digital handheld scanning process as additional work beyond their current manual system tagging responsibilities. As a result, it was sometimes difficult to record scanning data every day, for every product, and for every participating business in the supply chain. Because the oyster industry is a fast-paced production- and cost-focused industry, the additional work of scanning tags during the pilot was not prioritized.

Scanning daily, and consistently, did not present a problem for the distributors, restaurants, or the Crystal Seas Oysters processing plant. For the pilot, the Crystal Seas Oysters process was designed to be simplified in order to increase the quantity and the consistency of scans. However, for the harvester and truck components of the supply chain, and at the Motivatit Seafoods processing plant, establishing a consistent commitment to the pilot was challenging because the handheld scanning system was viewed as additional work to their current procedures. Even as a temporary endeavor, performing additional work on a volunteer basis was seen as unnecessary at times. The handheld device scanning process was designed to be capable of replacing manual data recording, and each participant agreed that if they were not required to perform a double entry (scanning and manual tag recording) then scanning would be a more efficient system than manual tag transfer.

# 8. Key Recommendations

## Digital Tags

The use of a digital QR-coded oyster tag with a GUID proved to be successful. The use of a handwritten tag in addition to the handheld scanning device procedure was perceived by some participants as additional work, but using only one or the other was not considered onerous. New technology such as NFC tags may prove to be cost-effective as the unit cost is reduced over time.

## Hardware

The Psion Workabout Pro 3 handheld scanning device proved to be easy to use and very robust. For some supply chain members, however, the cost of this device could be a significant barrier, and the use of a smartphone such as the Nokia Lumia 920, with a ruggedized case, may be a more practical solution. It is recommended that smartphones be researched and considered as a viable option.

It is also recommend that Wi-Fi transmitters be locked at the dock/dealer and monitored periodically. It also needs to be understood that if internet connectivity is not established, the Wi-Fi transmitter needs to be checked and fixed immediately. This task is not demanding but entails added responsibility to the handheld scanning device users at the dock/dealer.

## Software

The choice of a message-based software architecture was particularly successful for the handheld scanning devices. The CTE and KDE process proved to be an exceedingly efficient and modular solution that allowed for simple vessel implementation, and at the same time, supported immensely complex internal traceability at the participating processing facilities. It is recommended, however, that future versions of the software include a closable pop-up box to notify users that the handheld device needs to upload data to the server.

## Overall Process

The pilot demonstrated that full digital traceability is achievable, even when products are routinely commingled. Additional work will be required, however, as the oyster industry and regulators will need to review and determine whether or not digital traceability can be substituted for handwritten traceability. It is also recommended that digital traceability data be used to identify ways to improve overall efficiency and reduce costs of an operation.

The integration of HACCP and traceability also needs additional study, as it became evident that the software architecture and methodology used for internal traceability efforts throughout the pilot could be helpful to HACCP digital recordings.

## 9. Conclusion

The pilot showed that a fully digital oyster traceability system can be successfully implemented from vessel to plate. Digital traceability for the Gulf oyster industry was demonstrated for both large and small companies, and the pilot highlighted the benefits of handheld scanning throughout the supply chain.

While the pilot investigated a variety of means for attaching a digital ID to an oyster harvest tag, many of the technologies did not meet the requirements of the pilot, as they were deemed too expensive or impractical. Ultimately, the pilot team selected a QR code option that contained a pre-printed GUID on the existing oyster tag. While the individual QR code stickers placed on the tag were sometimes adversely affected by water, dirt, or sand, the pre-printed QR codes on the existing tag proved to have a better resistance to environmental factors.

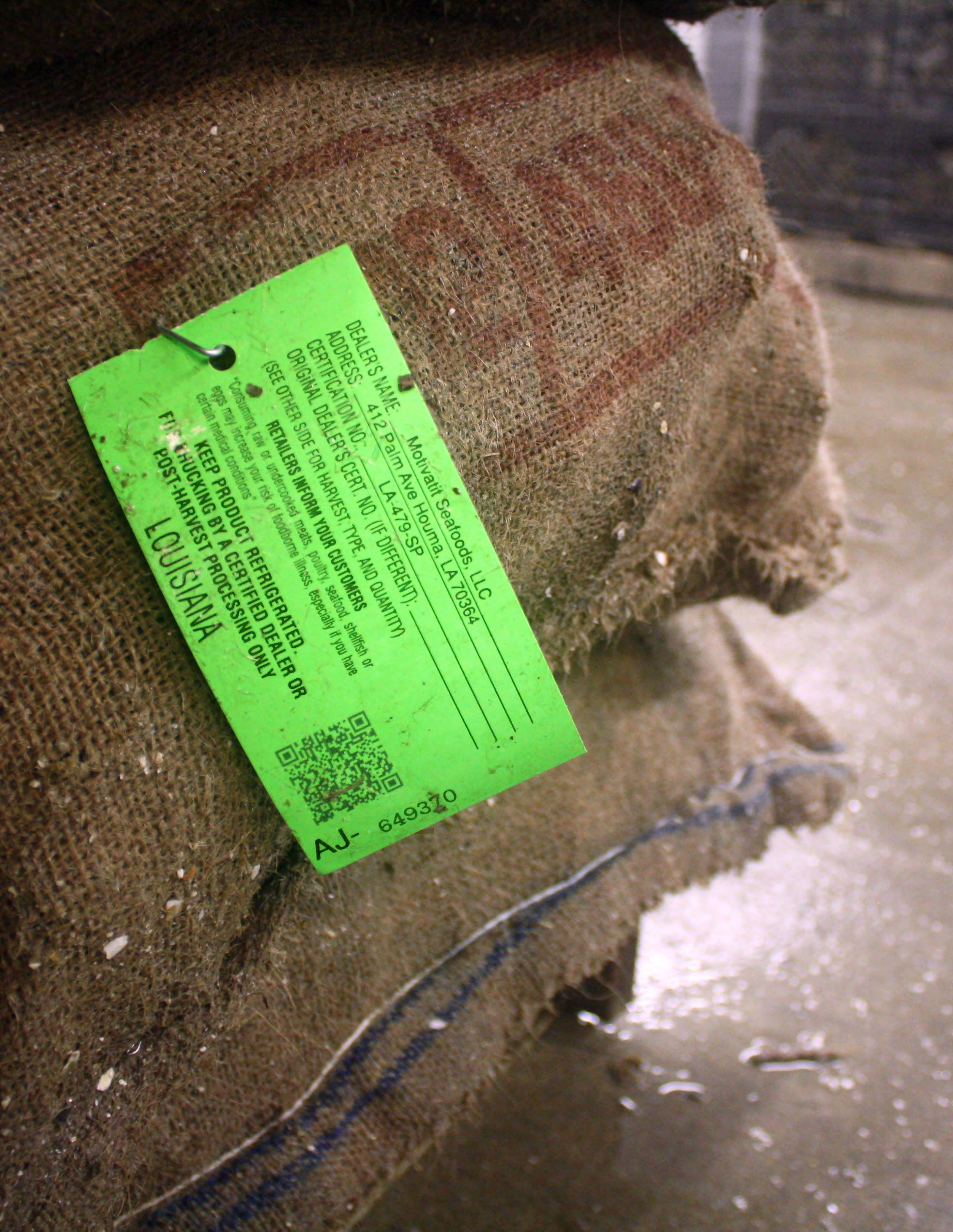
The principal handheld scanning device used for the pilot, the Psion Workabout Pro 3, was shown to be reliable, perform the tasks needed for a digital oyster traceability solution, operate in a disconnected mode, and connect to the internet when available. While only explored in a limited capacity near the end of the pilot, the Nokia Lumia 920 smartphone may be more appealing to some industry stakeholders given its reduced cost. Further research is needed, however, to ensure that smartphone technology will adequately meet the needs of a future digital oyster supply chain.

Significant increases in efficiency gains were observed throughout the supply chain during the pilot by integrating the electronic trip ticket system and using the handheld scanning device software for internal traceability. Challenges occurred for some pilot participants, such as harvesters, as they felt that both a manual tag in tandem with a digital QR-coded tag represented additional work. Downstream in the supply chain it became evident, however, that utilizing aggregated QR-coded tags, such as pallet license plates in the processing plant, allowed for both increased trust and efficiency.

The pilot also demonstrated that a digital traceability system can perform a complete trace back and track forward of the full oyster supply chain. The trial recall executed as part of the pilot showed that a digital traceability system can accurately determine the source of the products, as well as determine a track forward concerning where associated products were shipped.

Temperature monitoring was also investigated throughout the pilot through the integration of temperature recording with the Louisiana VMS. This action represented an evolution from traditional traceability to a combination of traceability and HACCP. The pilot team determined that as a result of cost and various external issues, it will take a significant effort to move forward with a temperature monitoring system at the vessel level.

Although there were some implementation challenges, the research conducted during the pilot showed that a digital traceability solution can assist the industry with its traceability challenges. The scanning process is simple and significantly improves on the efficiency of the current manual tagging system. The pre-printed QR code technology is proven to work under the various environmental conditions of the industry, and using the handheld scanning device is straightforward for supply chain members. The piloted solution can help to reduce risk associated with Gulf oysters at harvest, processing, distribution, and consumption as well as aid in ensuring that products on the market are safe.


DEALER'S NAME: Motivatit Seafoods, LLC
ADDRESS: 412 Palm Ave Houma, LA 70364
CERTIFICATION NO.: LA-479-SP
ORIGINAL DEALER'S CERT. NO. (IF DIFFERENT):
(SEE OTHER SIDE FOR HARVEST, TYPE, AND QUANTITY)
RETAILERS INFORM YOUR CUSTOMERS
"Consuming raw or undercooked meats, poultry, seafood, shellfish or eggs may increase your risk of foodborne illness, especially if you have certain medical conditions."
KEEP PRODUCT REFRIGERATED.
BY A CERTIFIED DEALER OR
POST-HARVEST PROCESSING ONLY
LOUISIANA
AJ- 649370