2.0 TRACEABILITY SYSTEMS IN PRACTICE

2.1 WHAT IS TRACEABILITY?

A simple, working definition of traceability is the ability to follow and identify a product unit or batch through all stages of production, processing and distribution, both forward and backward. This requires an independent "trail" that identifies:

- where a product or item is,
- where it has been, and
- what was done to it along the way.

Traceability can be envisioned as the ability to find a needle in a haystack by having records that tell you which needle, which haystack, who put it there, and exactly where they put it.[3]

2.2 WHAT MAKES A GOOD TRACEABILITY SYSTEM?

For the effective and efficient recording, maintenance and transfer of product information traceability systems must meet a number of criteria.

One-Up One-Down Traceability

One-up-one-down traceability is the minimum requirement of traceability regulations such as the US Bioterrorism Act and EU General Food Law. Under one-up-one-down traceability (Figure 2.1) each partner in the supply chain is responsible for linking input records to output records but is not responsible for information which may be several steps removed in the supply chain. For example, a retailer of groundfish in Los Angeles may not receive information from the processor in Vancouver as to harvest vessel(s), area of catch or date of catch. However, this information should be linked to the retailer through records maintained by the processor. One-up-one-down traceability is the simplest system to implement, provides the most flexibility for individual businesses, provides some privacy of confidential data but may be inefficient in the event of a traceback due to the number of contact points. The integrity of the system depends on all partners in the supply chain and is only as good as the weakest link.

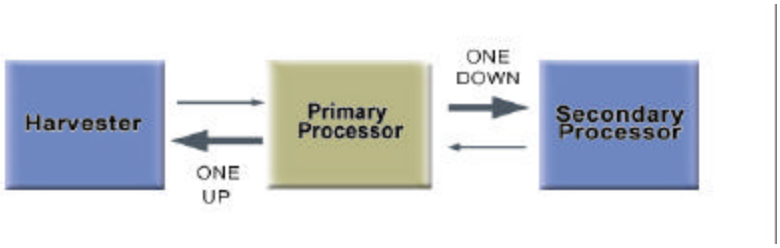


Figure. 2.1 One-up, One-down traceability model.

[3] Can-Trace Traceability of Seafood Guidelines (http://www.can-trace.org/)

Recording Appropriate Data

The system must record information that will allow it to meet the traceability definition provided above. A traceability system requires three basic information elements[4]: a means of identification for the product (***product identifier***), information about the product (***item information***) and a ***traceability linkage*** between the identifier and item information (Figure 2.2). The item information can be further described as follows:

Product Description - Information describing what the product is and how it was produced, stored and handled must be linked to the Product Identifier.

Business Identification. The identity of each business that handles the product unit must be recorded and linked to the Product Identifier.

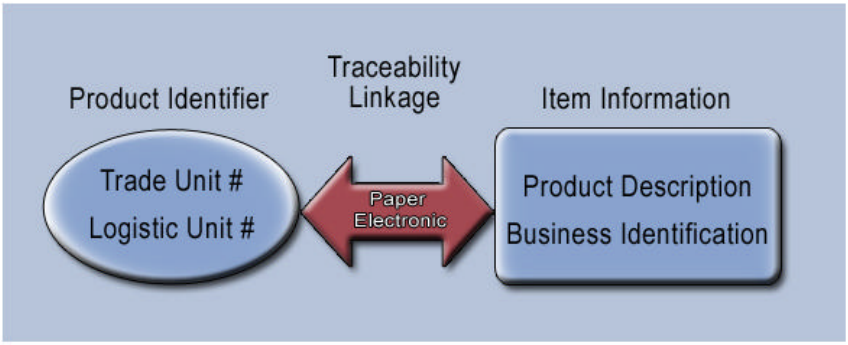


Figure 2.2 Essential elements of a traceability system.

The key to a successful traceability system is the assignment of product identifier codes to specific product (trade or logistic) units, and then maintaining the integrity of each unit (together with all relevant descriptive information) as it moves through the supply chain. The linkage between the product identifier and the item information can be as simple as a paper record (validation record or tally sheet) containing both pieces of information. Electronically compatible formats such as a bar code, spreadsheet or database records can also provide the required linkages.

Effective Data Transfer through the Supply Chain

The system must allow effective and efficient data transfer between stages in the chain. To facilitate data access and transfer at each step in the supply chain, records must be:

- Created and maintained in a timely manner
- Accessible in a timely manner
- Compatible with other stages in the chain – the scheme for recording, storing and transferring information must be seamlessly linked with preceding and following stages of the chain. This need for system compatibility extends to export markets.

[4] adapted from Federal/Provincial/Territorial Agri-Food Inspection Committee (FPTAFIC) document of Basic and Essential Criteria for Traceability systems, dated May 2004

Verifiable

The performance of the system must be verifiable. Independent verification of system performance should be part of system design. Currently, no country has a formal statement requiring an exporter's traceability system to be 'certified'. However, US Customs and Border Patrol are indicating that they intend to eventually require exporter's traceability systems to be audited and certified by a third party. In addition, the system and individual transactions will be subject to audit and verification by Customs. A similar informal system already exists in the EU. It is noteworthy that, when there have been food scares or border closures, products that have been ISO 65 / EN45011certified by an independent auditor have moved through Customs more readily than non-certified products.

Data Responsible Party

Traceability information for a partner (business) in the supply chain must be managed and stored in such a way that it can be easily accessed at a single point of contact. In the event of a trace back or trace forward, the authorities must have a single contact to obtain the one-up, one-down information relating to the supply chain partner. *The person who manages and is responsible for the traceability data for a partner in the supply chain is the data responsible party.* Each partner in the supply chain must have a data responsible party. The data responsible party can be the business for which the data is required; however, it may also be another business in the chain, or a third party outside the chain that has been appointed to manage the information. More than one supply chain partner may have the same data responsible party (see Section 2.5 on centralized traceability systems).

2.3 PRODUCT IDENTIFIERS

Batches, Trade Units and Logistic Units

Product identifiers are essential to traceability systems, without them, you cannot achieve traceability. Think about how difficult it would be to find a friend's house without a street name or house number if you have never been to the town they live in. There are three levels of product identification, batch, trade unit and logistic unit. A batch denotes product that is harvested or produced under virtually the same conditions. Batches generally refer to larger volumes of product and the point at which one batch becomes another may be decided by factors such as time, area, volume or interruption of production. At the harvester level, batches will likely be defined by entire offloads or, in some bivalve fisheries, they may be portions of offloads defined by the areas fished. Product from one batch may be placed or packaged in one or more containers or trade units. A trade unit ID is a unique number assigned to each trade unit, therefore no two trade units would have the same ID. Trade unit IDs allow the tracing of product on a unit by unit basis. Trade units could vary from entire vessel holds to totes of fish to individual fish. Trade units may be packaged together into larger units (e.g.. pallets) for the convenience of transport. These units are called logistic units. Logistic units allow the tracing of shipped packages. Trade units and logistic units may be the same units.

2.4 PRODUCT LABELLING

Product information is linked to an actual container of product through container labelling. Containers must be labelled or marked with a product identifier through which associated information contained on paper forms or in computer databases can be found. Without container labels, the verifiability of product identity is lost. Labels may also contain some or all of the product information to be passed to the next partner down the chain. At the harvester level, there may be circumstances where it may not be practical to affix a label to the product or container, such as when an entire boat load of fish is pumped directly into a processing plant. Fisheries where this might occur include herring, salmon and hake. In these cases, the hold of the vessel could be labeled.

An example of a label containing all the necessary product identifier information is given in Figure 2.3. This box label was obtained from Marine Harvest, a salmon aquaculture company.

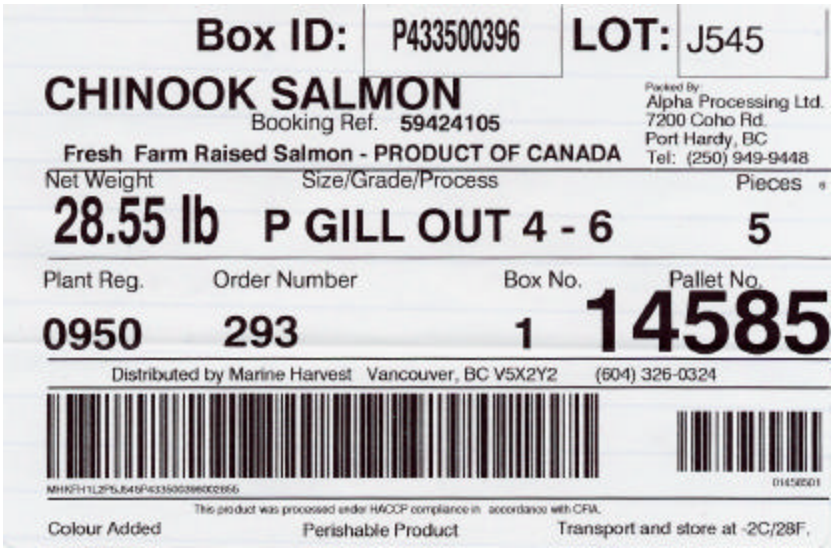
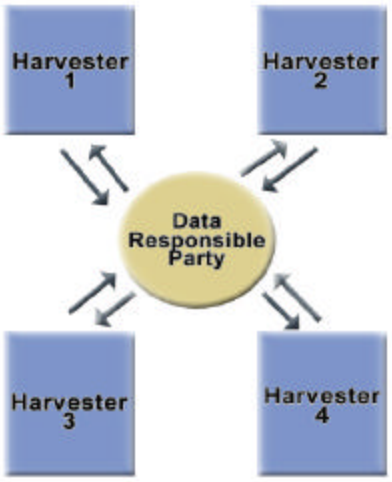


Figure 2.3 Product label for BC farmed salmon product

2.5 CENTRALIZED TRACEABILITY

In a centralized system, there is a single data storage and access point for several partners in the supply chain. Centralized systems often go beyond one-up-one-down traceability (Section 2.2) by providing traceability through several levels in the supply chain. These systems may be more cost effective and efficient for each partner in the supply chain compared to designing and maintaining their own system, but all partners must follow specified data standards and criteria for the privacy of information must be developed. Centralized data systems can be applied to sectors of industry (Figure 2.4a) and linked to other levels of the supply chain, or one system can be used to achieve full chain traceability (Figure 2.4b). Dockside monitoring programs are examples of sector based, centralized data systems for commercial harvesters.



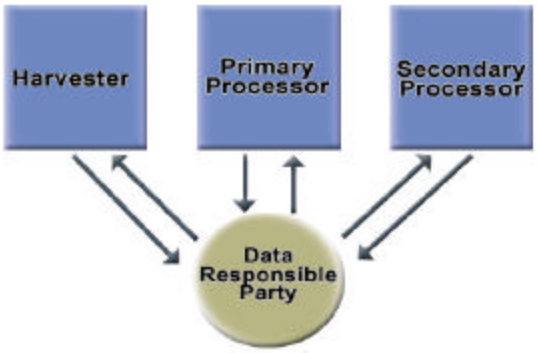


Figure 2.4a. Sector based centralized model. **Figure 2.4b. Supply chain based centralized model.**

It appears that, within the seafood sector, corporate-based one-up, one-down traceability systems are emerging rather than centralized systems. We were unable to find an example of a full chain, fishery specific traceability system after extensive web searching and contacts with the UK Seafish Authority, Tracefish, Seafood Plus and the European Seafood Safety and Traceability Organization (ESSTO).

> *"Seafish are unaware of a entire chain or sector of the fishing industry that has adopted the Tracefish/ EAN Seafood traceability standard."*
> *Dr. Jason Coombs, UK Seafish Authority*

There are significant barriers to implementing centralized traceability systems in the BC seafood sector, such as data confidentiality of fishing data and primary processor market information. The essential criteria for an effective traceability system can be met with a corporate based traceability system, however fishing organizations and/or government may wish to become involved in setting or implementing data standards. In BC, some of these barriers may have already been overcome with the evolution of dockside monitoring programs. These issues are addressed more fully in Section 5.0.

Our interviews with processors have concluded that so far, their response to traceability initiatives has been cost, product, market or regulatory driven (Section 4). Currently regulations differ for different product sectors (i.e. requirements for bivalves versus finfish). Buyers in Japan demand more traceability information than buyers in Hong Kong. These market differences may also present a barrier to the implementation of sector wide traceability systems in some fisheries.

2.6 USE OF DATA SYSTEM STANDARDS

The use of data standards in traceability systems provides a set of "business rules" to follow that facilitates the collection, storage and exchange of data. Traceability regulations define the data attributes (e.g. vessel ID, date of harvest) but do not define standard data formats for these attributes (e.g. YYYY.MM.DD for harvest date). The use of standard data formats facilitates effective and efficient data exchange, particularly in a non-integrated supply chain. Internationally recognized standard formats will be important in global markets.

The most widely used data format standard in the food industry is the internationally recognized EAN.UCC numbering system. Under this system, products, shipments, locations, production lines, boats, trucks, and other physical assets can be identified with a unique number, generally in the form of a machine readable bar code. Further information on bar codes and the EAN.UCC system is provided in Appendix A.

Bar codes and RFID technology are some examples of electronic methods through which coded information can be communicated in a standard way. Another example of a data exchange standard is XML. XML is a universally recognized standard that defines the information requirements and structure of a file in order to facilitate the exchange of electronic data from one computer application to another.

Section 2.9.2 summarizes commercially available seafood traceability software solutions. Most of these commercial databases packages use data format and exchange standards such as XML. It is important to recognize that these commercial packages are not the only means of addressing data format standards for exchanging information. What is essential is the understanding and use of recognized standard formats which can be used by a wide variety of software applications.

2.7 THE SEAFOOD SUPPLY CHAIN

To help understand the flow of information for one-up-one-down traceability (Section 2.2) one should be aware of the structure of seafood supply chains. Figure 2.5 provides a simplified model of the seafood supply chain in BC from water-to-consumer. The upstream stages of the chain (water-to-buyer) for wild harvest and aquaculture are quite different, but the downstream stages (post primary processor) are similar. Businesses such as transporters and cold storers that have custody of the product without purchasing or producing the product may be involved between chain partners. A more detailed view of the various supply chain pathways within the water-to buyer supply chain for wild fisheries is shown in Figure 2.6. The supply chain pathway within a specific fishery can be varied and complex, increasing the difficulty of tracing products. The various elements of the water to buyer pathways for wild harvest as well as finfish and shellfish aquaculture are defined in the accompanying inset boxes.

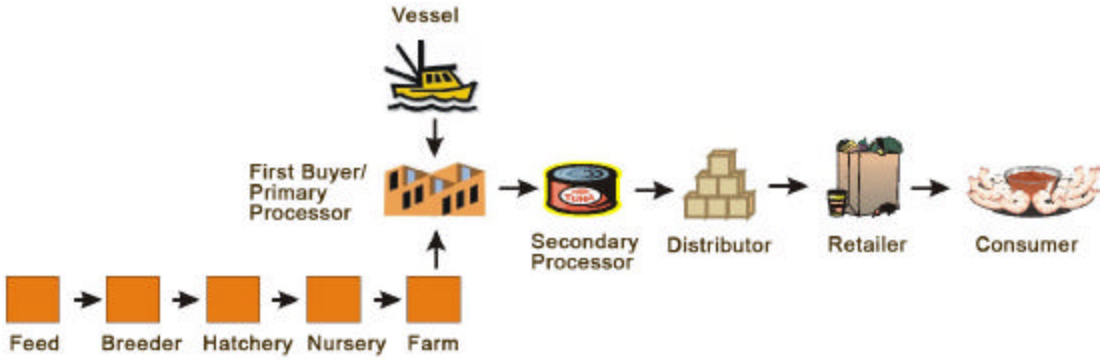


Figure 2.5 Seafood (aquaculture and wild harvest) supply chain

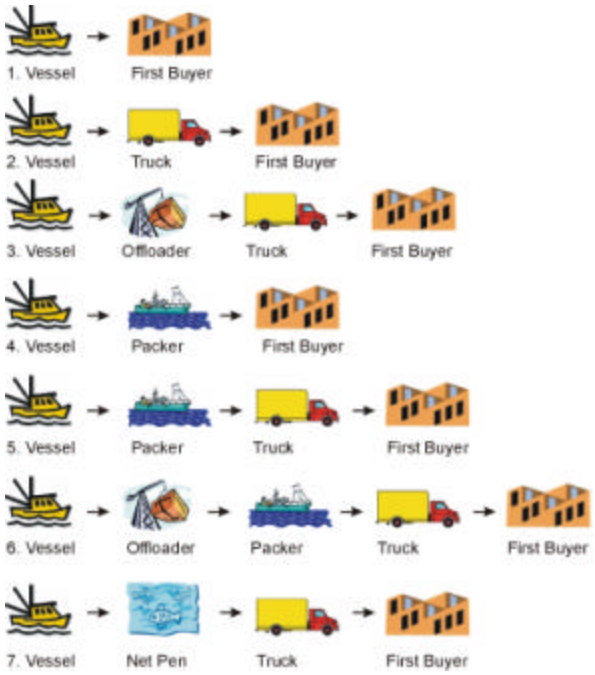


Figure 2.6 Wild harvest water-to-buyer supply chain pathways

Elements of Water to Buyer Pathway – Wild Harvest

Vessel	The vessel harvests seafood product. Basic processing operations may be carried out on board such as heading, bleeding, gutting, grading and freezing. Catch may be discharged by the vessel or by offloading companies. Harvesters are responsible for meeting a number of fisheries management data requirements (Section 4.3), some of which are also required for traceability.
Packer	A packer is a transport vessel that collects fish from one or more vessels and delivers it to a land based facility or transporter. Pooling of product is typical on packers, except in most shellfish fisheries where product is labelled and physically kept separate.
Offloader	The offloader is a business that discharges catch from a vessel. The offloader may carry out unit transformations (e.g. repacking), grading and sorting.
Net Pen	Live catch from vessels may be placed into net pens for storage until sale. Net pens are typically maintained by the vessel.
Truck	The truck is the land based transporter of seafood products. The truck may include other forms of transportation such as air transport. Documentation of shipments are made on a Bill of Lading.

Elements of Hatchery to Processor Pathway - Finfish Aquaculture

Feed manufacturer	The fish feed manufacturer manufactures feed for broodstocks, hatcheries and fish farms.
Breeder	Breeders are establishments that maintain broodstocks, often based on selection for specific characteristics, from which they collect eggs for hatcheries. Prior to dispatch, breeders may carry out operations such as quality grading.
Hatchery	Hatcheries are establishments that receive eggs from breeders and rear them through the hatching & juvenile phases until dispatch to a grow-out facility.
Farm (Grow-out)	Farms receive fish from hatcheries and rear them during the grow-out stage until dispatch to the slaughtering/processing link.
Live fish transporter	Live fish transporters may operate at two stages in the finfish aquaculture supply chain: 1) transport between hatcheries and fish farms; 2) transport between fish farms and processors.
Transporter	In the upstream portion of the supply chain covered by this project, transporters transport fish slaughtered on-farm to the processing plant.

Elements of Hatchery to Processor Pathway - Shellfish Aquaculture

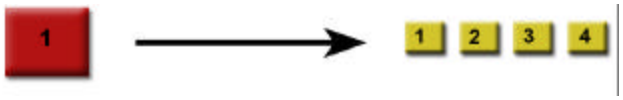
Hatchery	Hatcheries are establishments that maintain broodstocks from which they collect larvae and seed for nurseries. Prior to dispatch, hatcheries may carry out operations such as quality grading. While some hatcheries are located in BC, the major hatcheries supplying larvae and seed to the BC industry are located in the US.
Nurseries	Nurseries are establishments that receive shellfish seed from the hatchery and subsequently 'boost' its size through the use of rearing systems such as Floating Upwelling Systems (FLUPSY's).
Farm	Depending upon the shellfish species and the culture methods employed by the farm, farms will receive seed from hatcheries and/or nurseries – and rear them during the grow-out stage until dispatch to the processing plant.
Live shellfish transporter	Live shellfish transporters operate at three stages in the shellfish aquaculture supply chain: 1) transport between hatcheries and nurseries; 2) transport between nursery and farm; 3) transport between shellfish farms and processors

2.8 UNIT TRANSFERS AND TRANSFORMATIONS

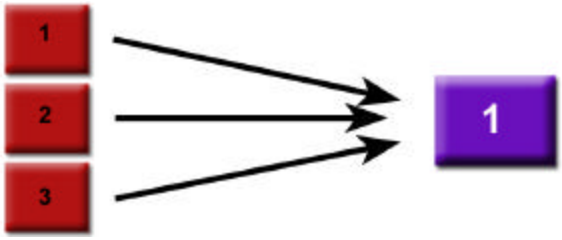
At each step in the supply chain, trade and/or logistic units may be transferred to another party or transformed by pooling or splitting. The more transfers and transformations that take place along the chain, the more complex traceability becomes. In a traceability system each unit transfer or transformation requires record keeping. The following diagrams provide typical trade unit transformations that occur from water-to-buyer.

1. **Unit Unchanged** – e.g. Fish stored in totes on a vessel delivered to a buyer in the same totes

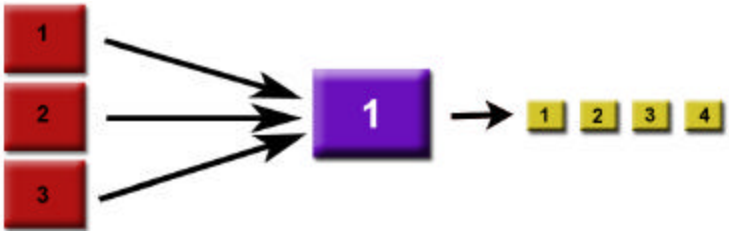
2. **Unit Splitting** –e.g. Fish stored in the hold of a vessel placed in totes by an offloader for shipping to a buyer



3. **Unit pooling** – e.g. Fish stored in the holds of three vessels emptied into the hold of a packer for shipping to a buyer.



4. **Unit Pooling and Splitting** – e.g. Fish from three vessels emptied into the hold of a packer then placed in totes by an offloader for shipping to a buyer.



2.9 OVERVIEW OF TRACEABILITY SYSTEMS[5]

2.9.1 Traceability Tools

Paper-based Systems

Fishing boats, transporters and fish processors, irrespective of size, will have some form of purchasing, order processing, sales and invoicing systems. In smaller companies these systems usually rely on the completion, storage and review of paper-based records by employees. Traceability of the product can be achieved by linking these individual systems and implementing additional procedures during the processing and storage of the product in the plant (Table 2.1).

Table 2.1. Advantages and disadvantages of paper-base traceability.

Advantages	Disadvantages
Based on existing quality assurance and stock control documentation systems. Inexpensive to implement. Flexible in terms of the processing systems to which it can be applied.	Processing and maintenance of data records is time consuming compared with other traceability methods such as bar coding and integrated IT systems. Manually intensive, with respect to writing and collating of records. Reliant on correct procedural operations being carried out, e.g. may be unreliable due to operator error. Trace-back of information is time consuming and difficult for paper based records. This is especially true where the process operations involve more than one raw material/ingredient. Records not easily summarized or reviewed; therefore only limited strategic use of information can be made.

Barcode Systems

Bar codes can not only be used to label and identify raw materials and products through the supply chain, but can also be used to label locations (e.g.. docks, processing stations) or individual pieces of equipment (e.g. weigh scales, processing equipment). Bar code systems rely on the use of hand held scanners for reading bar codes and inputting additional data, printers for re-labelling and a coordinated computer system to manage the information (Table 2.2).

[5] Adapted from A Guide to Traceability Within the Fish Industry. 2004. Eurofish and the Swiss Import Promotion Programme (SIPPO)

The system can be implemented at various levels, from reading information on incoming raw materials and labelling of final product (with all other records being paper based), to a fully integrated traceability system for all operations.

Table 2.2 Advantages and disadvantages of using bar codes and scanners for traceability.

Advantages	Disadvantages
Data input is easy and often menu led, minimizing potential errors. Additional information can be entered into the hand held device so that product quality records such as temperatures etc. are also included in the data-sets. Each scanner can be used to collect data from various process steps therefore minimizing capital expenditure and maximizing use of equipment. Real time availability of records results in improved stock and process control. This information is down-loaded to a data-base which can collate and process the information to provide the necessary reports and records.	Requires capital expenditure for equipment in order to successfully implement. This is especially true where processing information is to be automatically logged and integrated with the scanned data. Paper bar codes are easily damaged, losing all information. Technology can be unreliable, so an additional paper based system is recommended as a back-up system

Radio Frequency Identification (RFID) Tags

RFID systems use radio waves of specific frequencies to read, and/or modify data stored in electronic circuits or a micro-chip that is usually encased in durable plastic to form a "tag". The RFID system consists of 3 components, the RF tag, the transceiver or scanner, and a computer. The transceiver transmits energy in the form of radio waves via an antenna. When a tag is near the transceiver, the tag emits a radio signal that can be picked up by the transceiver and decoded to reveal the information contained in the tag. The transceivers can be incorporated into various types of equipment such as portals (doorways); handheld scanners; specific pieces of equipment (e.g. weighing scales) and have even been built into the glove of the person who handles fish boxes.

RFID tags can be attached to fish boxes, freezing racks etc. and are used to carry the traceability information in a format that can be read automatically and at a distance. The advantage of this method is that the box needs only to be placed on a scale or passed through a detector for the identification information to be automatically determined and only additional information added (e.g. quality grades, weight etc.). This can be achieved by inputting the data via drop down menus on a touch screen interface. RFID tags are well suited to harsh environments where barcodes fail. For example, RFID tags are embedded into crab floats and read by an on-board scanner during trap recovery to monitor fishing activity in the northern BC Area A crab fishery.

How technologically advanced a traceability system should be depends on a number of factors including regulatory requirements, market demands, and the operation and goals of a particular business. Considerations for implementing technology based approaches to traceability are summarized in Table 2.3.

Globally, traceability requirements are growing and the increased volume of data that will be collected in the future and the increased speed with which it will have to be accessed should be a major consideration in designing traceability systems. Traceability is already "*just part of doing business*" in the BC aquaculture industry. These trends suggest traceability information systems in the BC seafood industry should utilize and take advantage of technology-based solutions to remain competitive with other seafood industries around the world.

Table 2.3 Advantages and disadvantages of technology-based approaches.

Advantages	Disadvantages
Flexibility- the system can be customized to user's specific needs. The types of equipment, scanning systems, data-base software etc. can be adapted to meet individual companies requirements.	Requires capital cost at start up for hardware and software. But this should be evaluated against potential cost savings in material, labour and other resources.
Increased efficiency in data storage and access with increased volume and complexity of data. As volume increases in a semi-automated system you do not have to exponentially add staff to shuffle paper.	Relies on either ID tags/labels throughout process or Bar code scanning an additional capital cost.
Easier data compilation and production of statistics summaries for business management. Storing data in a database makes it easier to query and summarize information. For example, regulatory reporting can be done faster.	Requires training for staff in new equipment and new processes.
Less labour required for data entry and maintenance (i.e. lower labour costs).	May require higher level of computer expertise for some staff managing the systems.
Promotes structured processes which leads to increased efficiency.	Generally there is a higher comfort level with low-tech paper solutions and higher discomfort with change to electronic solutions.
Faster data communication with other partners in the supply chain or with internal divisions of a business.	Complexity of integrating the technology and systems. The technology should be suited/customized for the system, which requires understanding of the systems.
Less errors in communicating data.	
Less consumption of paper (environmental benefits).	
Less storage space required for archiving paper records.	
Increased information accessibility- the paper copy can only be physically accessed where it is stored/located, information stored electronically can be accessed from anywhere in the world with compatible infrastructure. For example webmail or internet based access.	
Increased security and auditing- paper copy can be physically seen by anyone with no record of who saw/accessed it, while electronic copy can have auditing for who created, edited, viewed the data with date/time stamps.	
Ability to translate information into multiple languages.	

2.9.2 Traceability Software Solutions

A number of traceability software solutions have been brought on to the market in recent years, largely in response to the EU regulations. As a result most of the solution providers are based in Europe. Table 2.4 summarises information on the major traceability software solutions currently available.

Most of the packages are aimed to facilitate compliance with the European Tracefish standard and hence store and share data in XML format. Current users in North America are largely from the aquaculture industry.

Most of these software solutions do, or can be adapted to, accommodate water to buyer stages of the supply chain. The Trace 2000 software package developed by C-Trace in the UK is designed specifically for this stage and is essentially an onboard electronic logbook that is being marketed as a traceability tool. Electronic logbook software packages are in use and/or in development throughout the world. For example, Archipelago recently completed an electronic logbook pilot project for the salmon industry in BC. This system uses satellite communications to report catch from a computer on board the vessel to a database on a land based computer system.

Table 2.4. Summary of selected traceability software solutions.

Software Brand Name:	Tracetracker	Wisefish	Traceway	NuTrace	Trace 2000
Developed by	Tracetracker, Norway.	Maritech, Norway.	UK-based Rontech and Nesco Weighing.	Marine Harvest, Norway.	C-Trace, UK
Canadian support	Have just opened a Canadian office	Maritech Canada (NS)	Not advertised	None advertised	None advertised
Designed application	Generic to food industry	Designed specifically for the seafood industry.	Generic	Specific for *Marine Harvest* supply chains.	Specific to fishing vessel operations. System is essentially an electronic logbook solution.
TraceFish compatible (data in XML format)?	Yes	Yes	Yes	Not known	Yes
Major seafood clients	• *Fjord Seafood* (aquaculture) • *Skretting* (fish food producers)	• *SIF Canada* (NS processing plant) • *Clearwater Seafoods* (large N. American seafood company) • *Pan Fish* (2nd largest global producer of farmed fish).	Not advertised	*Marine Harvest* – world's largest aquaculture company, and the largest global producer and supplier of farmed salmon.	Not known
Can it accommodate boat to buyer stage/s?	Yes	Yes. By using *Wisefishing* and *Wisetrawler* modules	Does not appear to.	Not known	Yes, designed specifically for this stage of the supply chain.
Notes:			Includes both software and hardware (data logger attached to weighing device etc.) solution.		
URL	www.tracetracker.com	www.wisefish.com	www.rontec.co.uk	www.marineharvest.com	http://fish.jrc.cec.eu.int/shee l/partnership/c-trace.htm