Framework Adjustment 4

to the

Atlantic Herring

Fishery Management Plan (FMP)

Prepared by the

New England Fishery Management Council

APPENDIX I

Potential Applicability of Flow Scales, Hopper Scales, Truck Scales, and Volumetric Measurement in the Atlantic Herring Fishery

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Discussion Paper:
Potential Applicability of Flow Scales, Hopper Scales, Truck Scales and Volumetric Measurement in the Atlantic Herring Fishery

Prepared by Council Staff for the Herring Committee July 2010

Amendment 5 Draft EIS
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1.0 FISHING VESSEL EQUIPMENT AND PROCEDURE

The following information was collected via personal communication with several helpful industry members.

1.1 HARVESTING

On a typical herring boat the net is brought alongside the boat and a vacuum pump is lowered into the net to draw the fish out of the net and onto the boat. The catch enters the boat through a "bell" (Figure 1) and are pumped through a series of tubes and pipes (Figure 2).

Figure 1. A bell, the beginning of the pumping process on a herring vessel

Figure 2. Example of tubing used for pumping fish

The catch is first drawn across a de-watering box (Figure 3, Figure 4) where some of the water that the pump brought on board with the fish is removed. If there are a number of particularly small fish in the catch then the de-watering box mesh may get clogged, and the efficiency of water removal decreases (Figure 5). From the dewatering box a series of metal chutes are employed which can be blocked off in differing areas to force the catch in different directions (Figure 3, Figure 6), in order to channel the catch to different holding tanks (Figure 7).

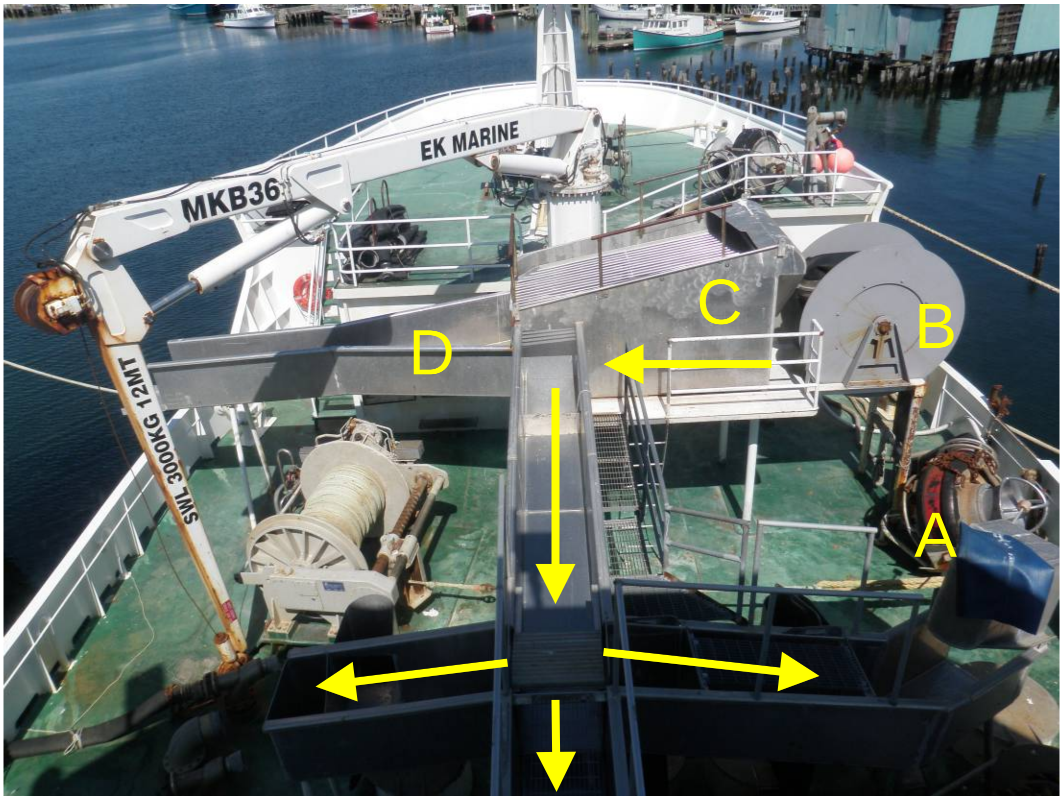

Figure 3. One vessel's system for pumping fish, where fish would move from the bell (A), through the extendable tubing (B) to the de-watering box (C) and through a series of metal chutes to various holding tanks. The arrows demonstrate the movement of fish, while the chute marked (D) channelizes the removed water off the boat

Figure 4. A De-watering box on another vessel, from the front

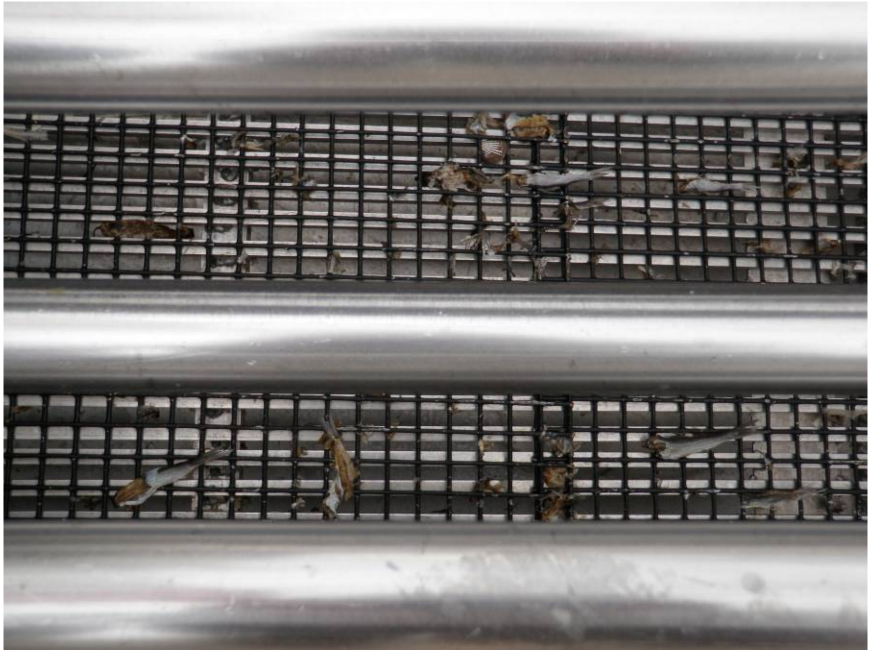

Figure 5. Detail of the lower half of a de-watering box, demonstrating how small marine life and detritus can catch and clog on the mesh

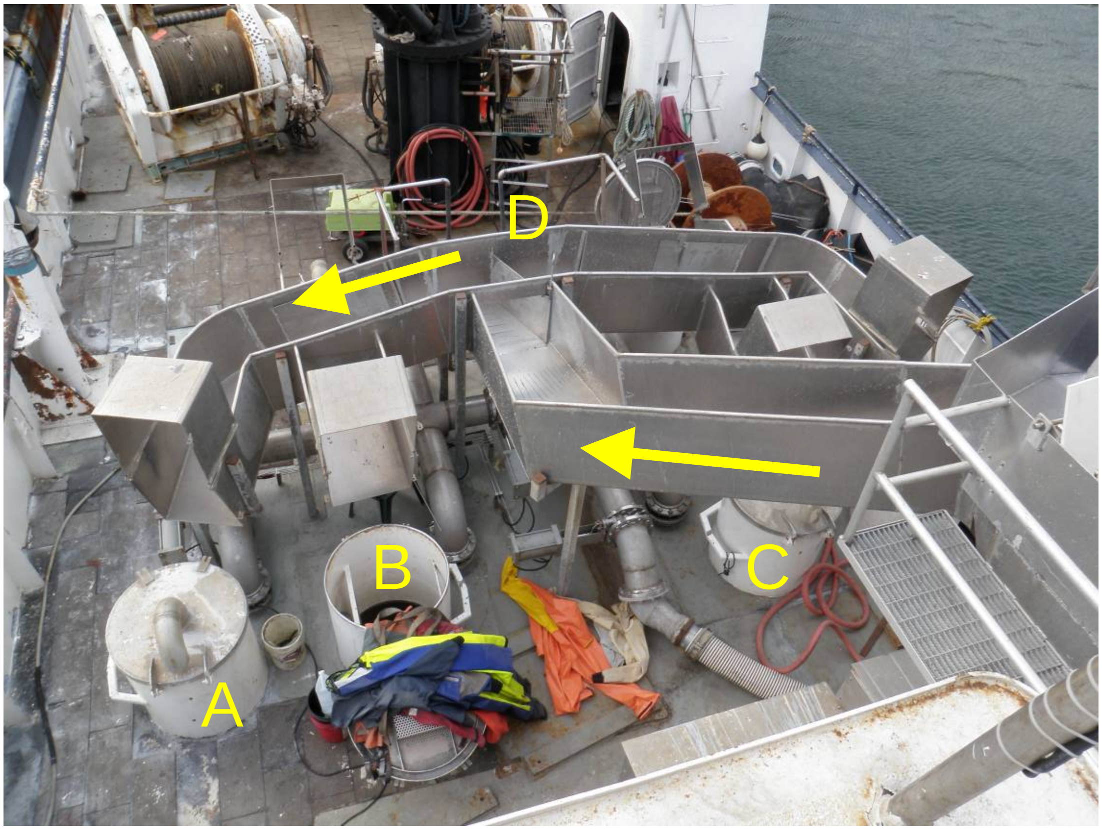

Figure 6. A different boat's metal chutes, used to channelize the fish to the different holds (A, B, C), with one side closed off (D)

Figure 7. Detail of channelization (A) into the holding tank (B)

Once in the holding tank cold water is employed to keep the fish fresh (Figure 8, Figure 9). Some boats will dewater the tank out at sea to get rid of the enzymes from the herring's stomachs and re-fill the holding tank with fresh water. The enzymes can build up in warm water and cause the fish to decompose and potentially lose their skin.

Figure 8. A holding tank, empty

Figure 9. A full holding tank, with fish and water

1.2 OFFLOADING

Once the boat docks, the fish are pumped back out of the hold onto shore; in some ports a pump which is separate from the vessel, typically located on the dock, is employed to move the fish off of the vessel (Figure 10) and in other ports the vessel has to reverse the boat pump. During offloading a series of tubes and pipes are employed to move the fish (Figure 11). This process varies with different boats and different ports, but in most cases the fish run back over another de-water box and out to fill up either containers or trucks (Figure 11, Figure 12, and Figure 13).

Figure 10. This pump, situated on a dock, is used to move the herring from the boat and into the de-watering box and eventually a truck or container, situated portside.

Figure 11. When a boat offloads at this port the herring move in the pipes, some 20 feet off the ground (yellow arrow), into the dewatering box (A) and then into a truck (not pictured).

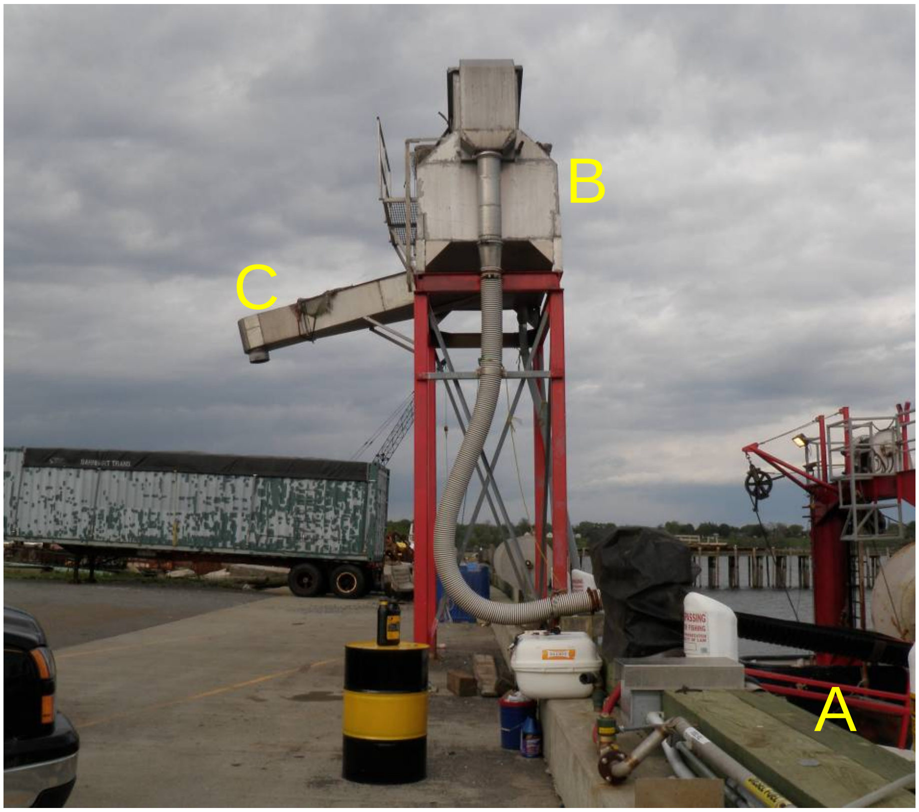

Figure 12. At this port herring are unloaded from the vessel, into tubes on the dock (A), up through another tube and into a dewatering box (B). Trucks drive under the end of the dewatering box (C) and fish are dumped into containers or the truck itself (not pictured).

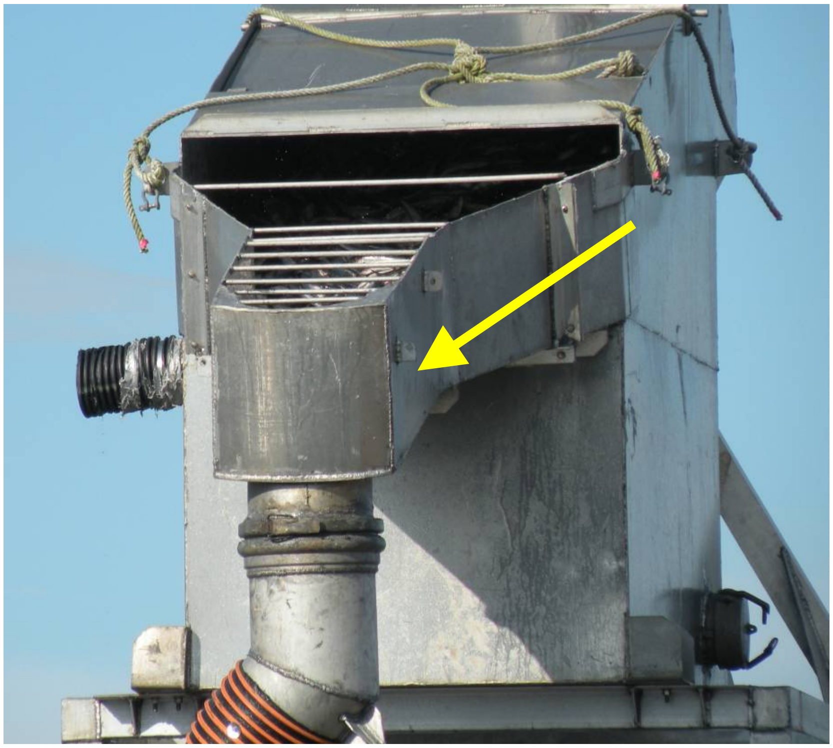

Figure 13. A de-watering box with fish on their way to the truck

The containers and trucks vary in size and dimensions that depend on the buyer, location, and time of year(Figure 14 and Figure 15). Truck sizes can range from 18 wheel trucks to box trucks, and containers can vary from bags to large bait containers (Figure 16). Some extended, 22 wheel trucks may also be employed to carry the herring.

Figure 14. Trucks picking up herring in Portland, ME clog the streets as they wait to be filled.

Figure 15. A flatbed truck carrying bait containers as it is being filled from the de-watering box. A man holds a tube in place to direct the flow of herring.

Figure 16. Bait containers wait to be filled on the side of the dock.

Although the de-watering box gets rid of some water, this process in not very thorough and some of the water stays with the fish (Figure 17 and Figure 18). Some trucks will pull aside, allow the water to flow out of the truck and the fish to settle, and then will come back to be filled further (Figure 19 and Figure 20). With current regulations most boats can only land their fish two days out of the week, and therefore the scene at the dock can be crowded and hectic during those days, and deserted on other days (Figure 21 and Figure 14).

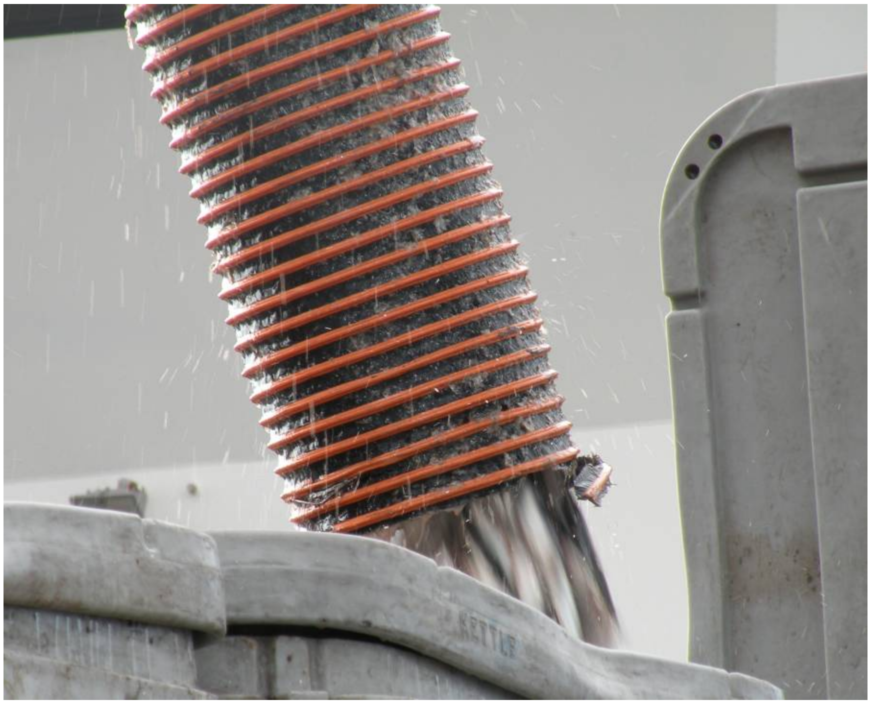

Figure 17. Herring and water are pumped into a bait container

Figure 18. Filled bait containers to the point of overflowing.

Figure 19. A bait truck waits to de-water after the truck is filled with herring.

Figure 20. The amount of water discharged from a bait truck after being filled with herring for only a few minutes.

Figure 21. Trucks line up down the road, all waiting to be filled with herring.

Ice is occasionally employed for keeping fish cool within a truck; however the cold water systems on the vessels maintain temperatures for long enough to ensure the quality of fish for bait purposes. If the herring are for human consumption, ice will likely be used. The filled trucks can be destined for many locations from down the street to several states away. Buyers of herring differ based on the seasons, and therefore so do the destinations.

Payment is typically received after the fish arrives at a destination, when the two parties will agree on how many pounds of fish were received. The number of pounds purchased may be agreed upon based on assumed volumes, which come from the container or truck used, and herring are not often weighed. A typical assumption used by captains and buyers is that 5% of the estimated volume of fish once in the containers is comprised of only water.

1.3 EQUIPMENT

Although the sizes of the vessels and the holding tanks therein differ, the size of hose or pipe used is relatively standard. Similarly, the de-watering boxes tend to be the same on the vessels, although on land they come in much larger sizes.

Vessel	Pump Company	Pump Rate (tons/hour)	Extreme Rates	# Pumps
1	Ryco	100	150	2
2	Trans Vac	50	60	1
3	Trans Vac	60	70	1
4	Ryco	60	70	1
5	Combo/self made	72	-	1

Table 1. Visited vessels pump specifications. Pump rates vary, and depend on the incline of the pipe or tube used; the steeper the incline the slower the pumping. Likewise, size of the fish will change the rate of the pump. Both the FV Sunlight and FV Starlight have pumps which reverse, meaning the pump will suck for 15 to 20 seconds and then discharge for 20 to 30 seconds.

Vessel	Size of Boat	Size of Pipes	Inflow	Outflow	Dewater Box	No. of Tanks	Size of tanks (each)
1	164' 10.5"	10"	16"	10"	-	10	between 100,000 + 240,000 pounds
2	-	8"	8"	8"	4'x6'	4	50,000 pounds
3	129'	8"	8"	12"	4'x6'	6	between 75,00 and 100,000
4	95'	8"	8"	12"	4'x6'	6	between 35,000 and 45,000
5	112'	8"	8"	12"	5'x5'	4	22 cubic feet

Table 2. On-board equipment by visited vessel.

	Ports Typcially Utilized			
	Osprey and Western Venture	Ruth and Pat	Starlight and Sunlight	Providian
Portland ME	x	x	x	x
Rockland ME	x	x	x	
Stonington MA				
Vinalhaven ME			x	
Cundy's Harbor		x		
Lubec/Eastport ME				
Prospect Harbor ME	x			
Bath ME				
Sebasco Estates ME				
Newington				
Portsmouth				
Hampton/Seabrook				
Gloucester MA	x		x	
New Bedford MA	x	x	x	
Fall River		x	x	x
Point Judith				
Newport				
North Kingstown				
Cape May NJ		x		

Table 3. Estimated frequently visited ports, by vessel, compared to Amendment 1 to the Herring FMP's "Communities of Interest"

2.0 PROCESSING FACILITIES

The portside offloading at processing facilities begins in the same way that direct offloading to trucks does, with large quantities of product moving off the ship via tubes and a portside pump (Figure 22). The herring are pumped up and over a de-watering box but prior to dropping into the truck or container, are moved along a short conveyor belt. This belt allows even more water to be drained from the fish (Figure 23). If the herring are to enter the processing facility rather than a truck or container, the herring are pumped from the dewatering box into the facility (Figure 24).

Figure 22. A dockside pump utilized for removing fish from the hold and into the processing facility.

Figure 23. The herring, after pumped off the boat and to the de-watering box (A) are then are either deposited into trucks or poultry bins via a hose for bait sales (B) or into the facility via a conveyor belt (C) and then into tubes into the plant for the food market. Meanwhile cold water is re-circulated between the boat and the storage tank (D) via pipes (E).

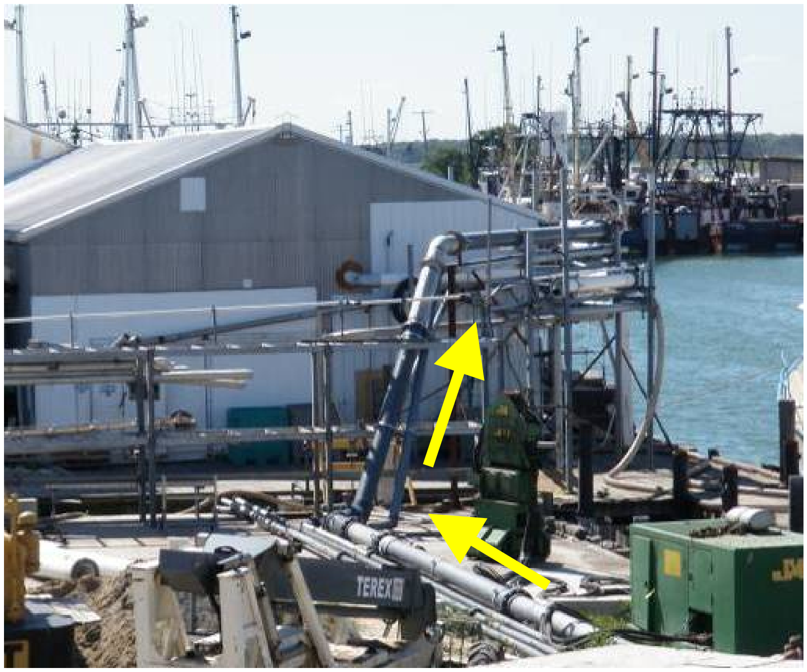

Figure 24. Transportation pipes and hoses entering the processing facility after coming from the dock.

Once in the facility the fish are stored in a holding tank until they are moved into the sorting process via a conveyor belt (Figure 25). The machines sort the herring into either four or five different sizes, and the bycatch also drops out (Figure 26). Once sorted, the herring are moved into one of three rooms, depending on their size.

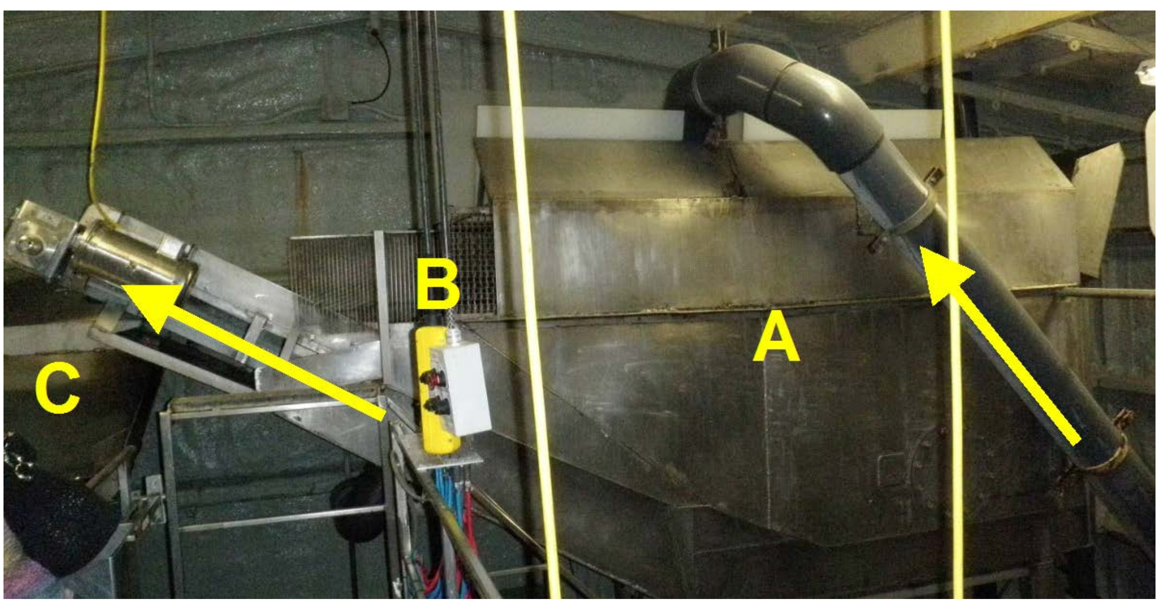

Figure 25. One of the holding tanks used in the process (A) with the controls for all the pumps which move the fish into the facility (B) and the conveyor belt (H) which begins the sorting process.

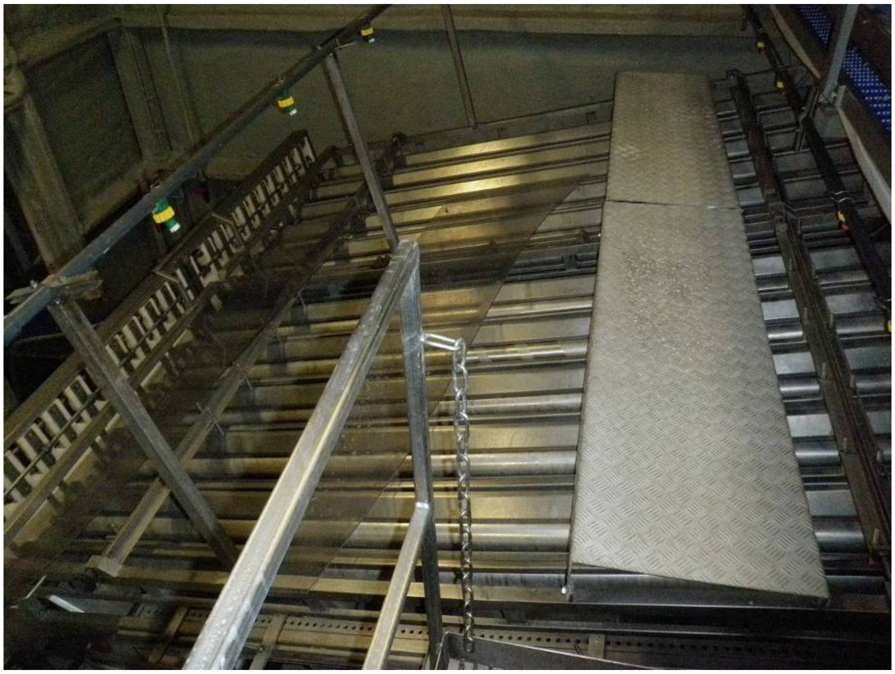

Figure 26. A sorting machine in which different sized herring fall to different levels depending on their ability to fit though the bars.

In each room, upon entering, the herring are manually sorted in order to remove bycatch, and then conveyed into a holding tank. From the holding tank the fish are conveyed into a hopper system, which has two scales within it to parse the fish by a specified weight for packaging (Figure 27 and Figure 28). The packaging, which is done manually, consists of dropping the fish into a plastic bag, which is then placed inside of a box (Figure 29). The first room contains four of these hopper systems which operate at six tons an hour, average.

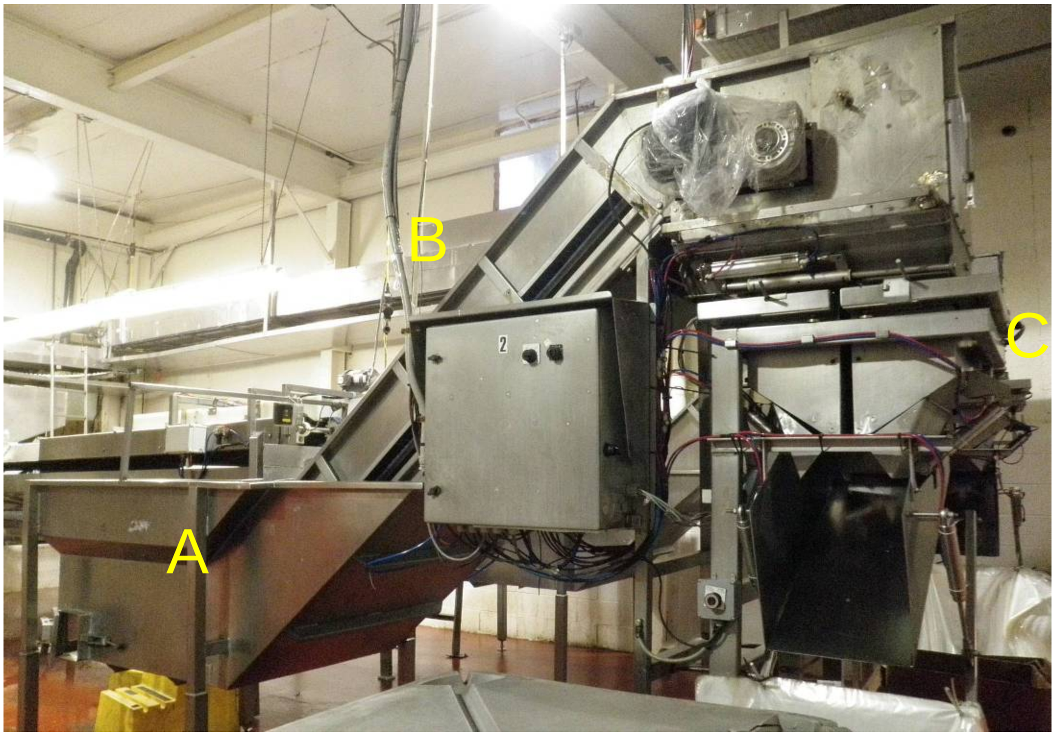

Figure 27. A full hopper system with a small holding area (A), a conveyor (B) and a two hoppers (C).

Figure 28. The dual conveyor belt picks up fish in small and large increments, to be used to fill the hoppers to the desired weight for packagaing.

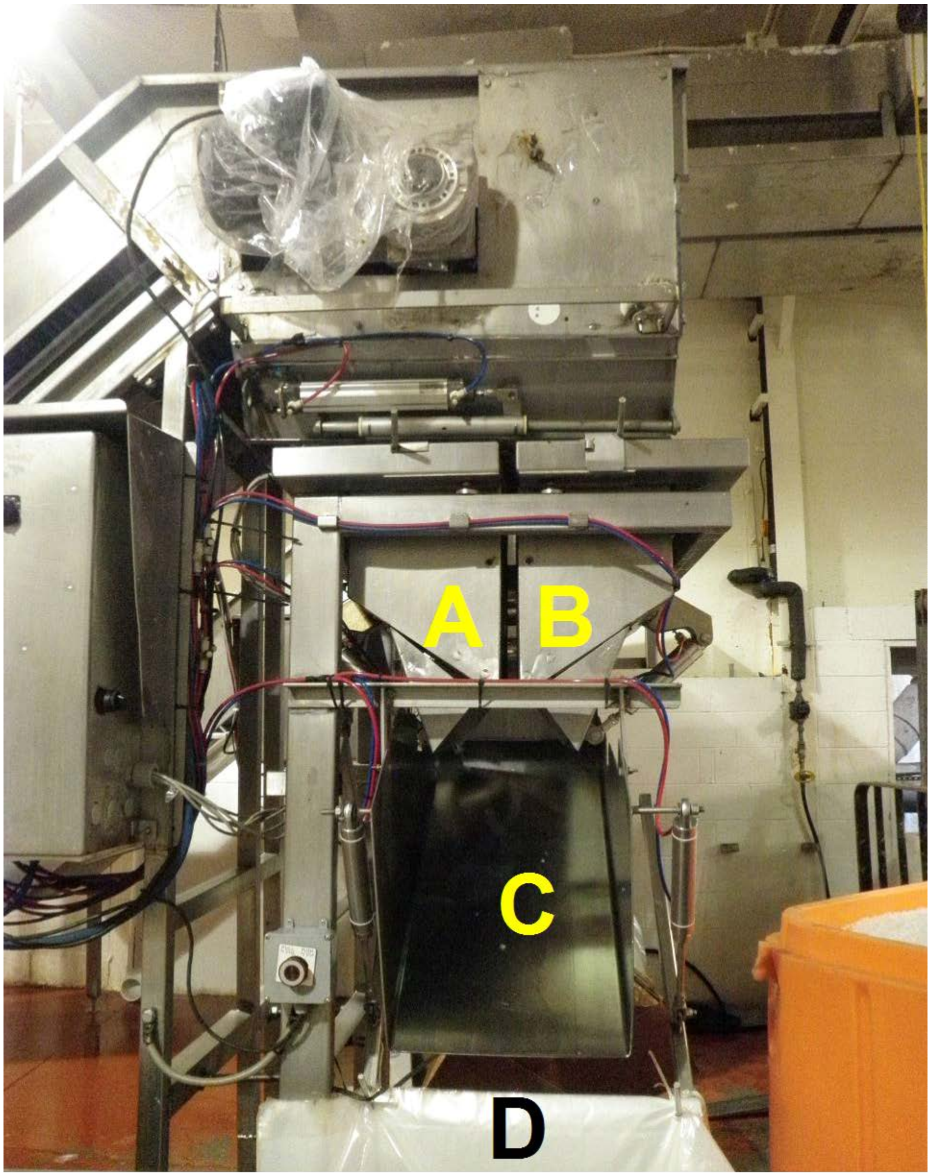

Figure 29. Each of the two hoppers pictured here (A and B) has an electronic scale to verify the total weight of the fish. As one hopper opens to drop the fish down the chute (C) and into the packaging (D), the other hopper is being filled and the contents weighed and later opens as the first hopper begins to fill again.

In the second room, however, there is a processing line which does not contain any machine, and all sorting and packaging is done manually, using standing scales. In the third room there is a processing line in which even the packaging is done by machine (Figure 30). Both of these rooms also contain hopper systems (one in the second, three in the third), and each line is used depending on the size of the fish and the amount of fish being brought into the facility.

Figure 30. The completely computerized packaging system, which is utilized after the hopper system.

There is an advantage to having each box weigh as close to the desired weight as possible. After the boxes are taped up they are either loaded into a freezer to sell later (Figure 31) or shipped out immediately. In either case, the shipping costs are based on the weight of the boxes, and therefore it is in the interest of the seller to keep the weight to a specified measure, such as 20 kilos.


Figure 31. Boxes of fish stacked floor to ceiling in the freezer, waiting for shipping.

The previous discussion was based on a site visit to Lund's Fisheries, Inc, which can process around 480 tons of herring a day and utilizes seven 2,500 horsepower engines in order to chill the product. The two other major processing plants involved in the herring fishery, NORPEL and Cape Seafoods, are assumed to be similar in operation for the sake of furthering management measures. Cape Seafoods is reported to have two scales on each of four processing lines as well as one scale on each of the other two processing lines. It should also be acknowledged, however, that Lund's operates within the food market and may therefore operate with differing equipment and under different standards.

3.0 FLOW SCALES

Three scale companies were approved by the NMFS Alaskan Regional Office (ARO) for their at-sea scales: Scanvaegt, Pols, and Marel. Approximately 6 years ago Pols was bought by Marel, and then approximately 3 years ago Scanvaegt was also bought by Marel. Since then the personnel at the ARO have been working with the people of Marel to continue to maintain and certify the at sea scales. The only other company that produces marine scale of the flow and hopper variety in the US is Ryko.

In both flow scales and hopper scales a computer monitoring system comes included. Both companies (Marel and Ryko) extol the wonders of having computer systems helping to control production and monitor data. Marel claims that the speed of the pumps can be controlled by the computer and that the monitoring benefits will aid in optimizing the system by pointing out the strengths and weaknesses of the fish processing on board or portside.

Certification of both types of scales is typically conducted by either the NMFS personnel or the state Department of Weights and Measures.

3.1 DESCRIPTION

Photo Credit: Marel

Flow scales are used in conveyor systems where there is a continuous flow of material, such as herring. It is typically equipped with a weight sensor that the fish pass over as they move down the conveyor belt. The computer attached to the sensors weighs the fish continuously and the resulting weight is a total of those measurements. The representative for Ryko highly recommended that a de-watering conveyor be set up before the flow scale rather than a de-watering box to ensure as much accuracy as possible. The Committee may want to consider a buffer for water within the measurements, regardless of de-watering strategy, as complete removal of water is difficult in a high volume fishery. The representative for Marel suggested that a cold water bypass system be developed that could immerse the fish once they are through the scale.

Both Marel and Ryko make their scales out of stainless steel, and are supposed to be easy to operate and clean. They were both designed to withstand the rigors of exposure to the ocean environment and direct contact with seawater. The scale is typically bolted to the floor to avoid movement. Neither scale is designed to be portable.The dimensions of the Marel scale are 6 feet long by 3 feet wide, and the height can be adjusted. The Ryko is 2 feet wide by 6 feet long.

Ryko scales claim to have never slowed a pump down by putting their scale into the system. Marel lists the thoughput of it’s flow scale at 70 or 80 tons per hour, depending on belt size, which would slow some of the surveyed boats down.

Both scales are said to have motion compensation built within the system. The representative for Marel suggested that if the scales were to be exposed to the elements, particularly wind or freezing spray, that something may need to be built around the scales, suggesting the sensitivity of the measurements to the elements. The representative for Ryko suggested that the accuracy of a flow scale was between 3 and 7%

3.2 COST

The cost for an at-sea flow scale from Marel is estimated to be around $70,000. Ryko estimated that their flow scale, which works on both land and sea, would cost $50,000. Marel does not currently make a land-based flow scale, but are working on developing one currently, and once certified will likely cost around $70,000 as well.

The Marel scale costs between $3,000 and $5,000 to install plus travel and expenses for the installation technicians. Freight is between $1,000 and $1,500. The Ryko scale ships for between $500 and $1000 with a crate fee of around $500. The majority of Ryko owners do their own instillation.

3.3 MAINTENANCE

Maintenance for the Ryko scales is not expected to be great, and phone support is free, and parts can be ordered individually online. Maintenance for the Marel scales vary, but for vessels going out to sea for multiple months on the West coast, they offer a package of all the parts that could break for $15,000.

3.4 EXPERIENCES

Mr. Kingsolving, a NMFS employee who works with flow scales in the Pacific Northwest and Alaska shared his experiences from the past few years with the Pollock, Rockfish, Flatfish and most recently the Pacific Cod fisheries . He mentioned that space and experience can become large issues when flow scales are used on boats, and suggested that the herring industry might not be the right fit for flow scales at this time. On the west coast his experience was that the cost of a flow scale, total, tended to cost around $100,000 and that the scales themselves needed continual maintenance and tinkering by people experienced in mass-processing facilities, and ought to be used on boats and in areas where mass-processing equipment is routinely used, such as the "motherships" and processing vessels from the west coast. He also mentioned that certification and maintenance issues can become difficult when state weigh-masters become involved and have different standards than the federal agency.

An industry member from the Atlantic herring fishery who owns a processing vessel also shared his experience with a flow scale. Purchased recently, he bought the flow scale used from a company in Norway for around $80,000. The vessel has a 200mt tank, which when the scale was installed, provided fish to two separate de-watering belts before the fish were weighed. The fish then went on to be processed.

The scale itself was a Marel 3-axis, motion compensated scale, which was designed to work on boat. According to his experiences, however, if the scale was not mostly dry and the sea was not calm then the weights that the scale took would be off by several orders of magnitude. In addition, if the catch composition was made up of smaller fish then the scale would also have difficulties taking accurate weights. He proposed that the problem was in the design; that the scale had been made for fisheries which processed larger fish, one at a time, as opposed to being made for use in a pelagic fishery such as herring.

4.0 HOPPER SCALES

4.1 DESCRIPTION

A hopper scale utilizes different chambers which fill up at differing times to keep a continuous flow of product moving through the scale. The advantage of a hopper scale, according to both the Ryco and Marel representatives, is that it can be built in many different sizes to accommodate multiple situations, while still being a relatively simple scale (Figure 32 and Figure 33). They are also said to be easy to calibrate and maintain and can be built for use on land or at-sea. Hopper scales can also be built with multiple hoppers, in which a diverter assures that while one side is filled and weighed, the other side is released, ensuring a faster process.

Figure 32. A Ryco marine hopper scale, in which the fish move from the upper box to the lower box, where the fish are weighed.

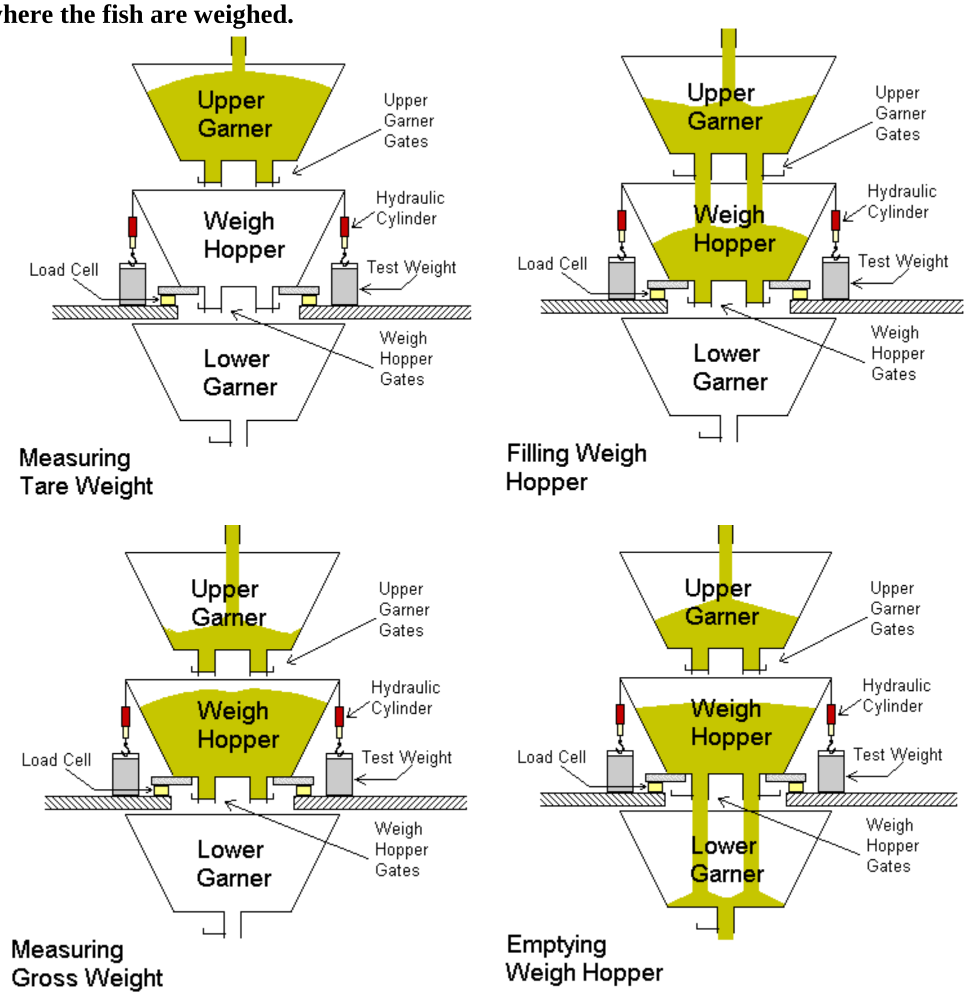

Figure 33. A step by step process through the basic hopper scale process. First, the Upper Garner is filled with the material. Second, the material is released into the Weigh Hopper, where the weight

will be recorded. In the third step, while the weight is being recorded, the Upper Garner Gates are closed, so that the Upper Garner can fill again. In the fourth step the Upper Garner continues to fill while the Weigh Hopper releases its contents into the Lower Garner, so that the Upper Garner can fill the Weigh Hopper again and start the process over. (Photo Credit: USDA)

The Marel representative estimated that the hopper scale would be able to keep up with the pace of the fishery, but may add between 5 to 10 minutes to the process at the worst. In either at-sea or portsides situations the water would need to be removed from the fish for the scale to work. Hopper scales can be portable as long as stationary on the trucks while the weighing is occurring, although long distance and frequent travel is not recommended. According to the Marel representative the hopper scales would be 4 feet by 4 feet square and the height would be adjustable from 5 feet or less to 30 feet. The Ryco representative stated 48 inch square as being the average size, but has seen hopper scales built as small as 24 inches square.

4.2 COST

The cost for an at-sea hopper scale from Marel is estimated to be around $40,000 to 50,000, depending on the modifications needed in each boat. A single hopper that would be situated portside would cost close to $30,000. The Ryko representative estimated that their single hopper would cost $20,000 including shipping and that a double hopper would cost between $35,000 and $38,000.

The Marel scale costs between $3,000 and $5,000 to install plus travel and expenses for the installation technicians. Freight is between $1,000 and $1,500. The Ryko scale ships for between $500 and $1,000 with a crate fee of around $500. The majority of Ryko owners do their own instillation.

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5.0 TRUCK SCALES

(All information courtesy of Wayne at Cat Scales, Paul Gerard with Advanced Scales and Rice Lake Weighing Systems, Ed at All-Tech Weighing Systems Inc (Portland, ME), Gentle Giant Corporation, The Portland Recycling Center, and the Scale-Mart Corporation).

Figure 34. A truck scale in use (photo credit: http://science.howstuffworks.com/question626.htm)

5.1 FIXED TRUCK SCALES

Fixed truck scales are scales which have been specially constructed and calibrated to give the user the most accurate information possible. Their size depends on what the user is looking for; the scale pieces are modular and a very large scale can be built to accommodate the largest of trucks. Scale pieces come in 20 and 30 foot increments. For the purposes of the herring fishery, the scales could be built to suit each location and the type of trucks that are utilized. There was consensus among all representatives that fixed trucks scales are the most durable of the truck scales for marine weather.

The general procedure for weight verification of herring would be to measure the truck once before the fish are transferred and once after; the difference would be the estimate of the weight of the herring. If the truck is going to be hauling out barrels or boxes full of fish, those items could be placed in the truck for the pre-fish weigh-in.

The difficulty is that in each location there would need to be a permanent structure which is large enough to accommodate trucks, infrastructure and the equipment associated with the scale (computers, on and off ramps, etc.). The scales also require a power source.

The estimates for fixed scales range widely from $30,000 to $100,000. The cost for the scale itself depends mostly on size; a middle of the road, 70 foot scale is approximately $40,000. The cost escalates, however, with the addition of shipping costs and installation, which typically cost $4,000 each. The cost of a foundation is also large and varies widely depending on the area of installation. The average estimate is around $15,000 to $18,000. All together the average scale would cost $65,000, if everything went well. One estimation that that came to a total of $100,000 included cement piers and other structural modifications beyond simple bulldozing and laying foundation. With the structural challenges at many offloading sites, installation of scales may be made significantly more expensive.

5.2 EXISTING TRUCK SCALES

One alternative to buying the fixed truck scales is utilizing existing truck scales which are for hire. Before a truck is scheduled to come and retrieve herring from the docks, a weight measurement could be required on its route. The truck would complete the loading of the herring as normal, and then on the way its destination, it could be weighed again. The difference between the two weights would be the weight of the fish, and any ice that is put in with the fish.

The advantage to this is cost; the approximate cost for weighing a truck is between $10 and $15, a cost which typically covers multiple re-weighs in the same 24 hour period. Many have been set up under very specific guidelines provided by the scale companies and the state Department of Agriculture, and they are inspected yearly by the same department. Certain companies even offer guarantees for their measurements; if you are fined or taken to court; they will either pay the fine or accompany the customer to court (CAT Scales).

Using existing truck scales and infrastructure presents two problems. The first is availability. While most ports that herring are landed (communities of interest, Amendment 1 to the Atlantic Herring FMP) have scales nearby (see Figure 35 through Figure 43), two ports have scales that are at least an hour away from the port: Sebasco Estates and Point Judith. The two most northern ports in Maine, Prospect Harbor and Lubec/Eastport, are not located near scales. The two island ports, Stonington and Vinalhaven, do not have scales on them, however it is questionable of trucks are used. In some ports, driving to an available scale may require driving a long distance, particularly if the truck is destined for only a few miles away. Encountering a scale may be difficult, due to the large spread of destinations for the trucks, and could lead to excessive driving. This in turn could ruin the fish, if they have to be in the heat for too long. Fish could also be compromised if the line for the scale is long, and the truck full of herring is forced to wait until the scale is free (Figure 14).

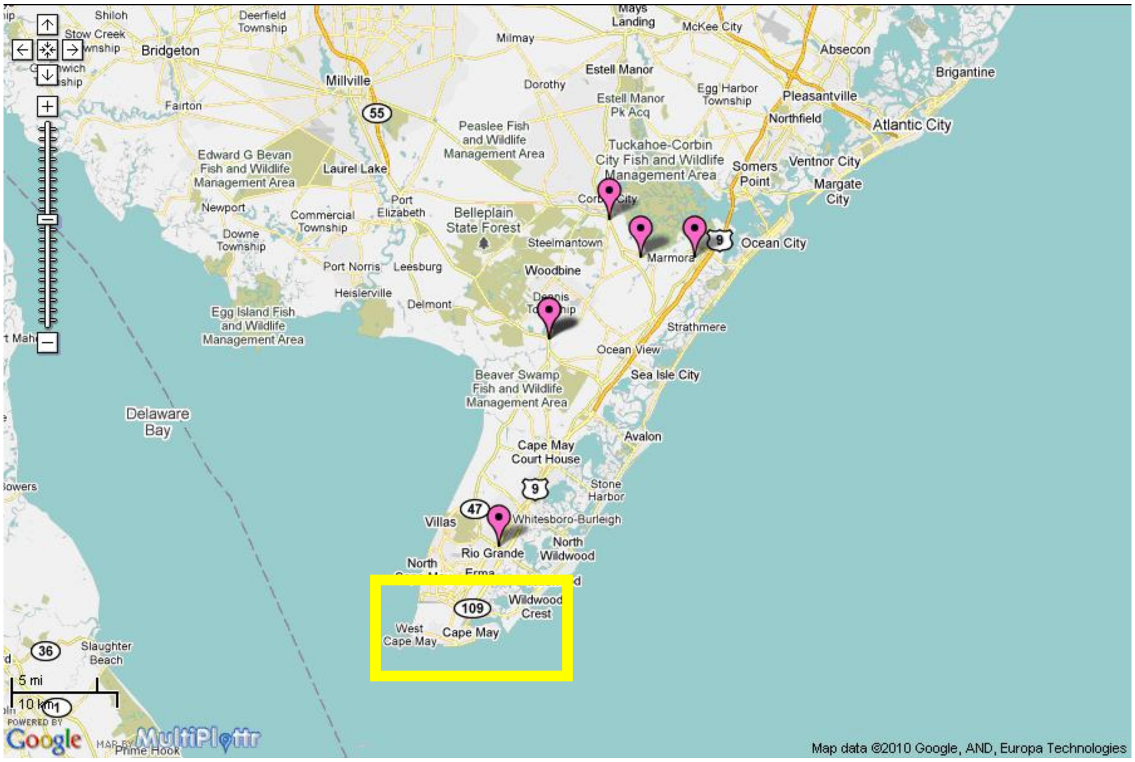

Figure 35. Existing truck scales in the Cape May, NJ area, marked with violet markers. The yellow box indicates a Community of Interest (Amendment 5). The closest approximate port-to-scale drive time is ten minutes and the furthest port-to-scale drive time is 33 minutes. (maps.google.com)

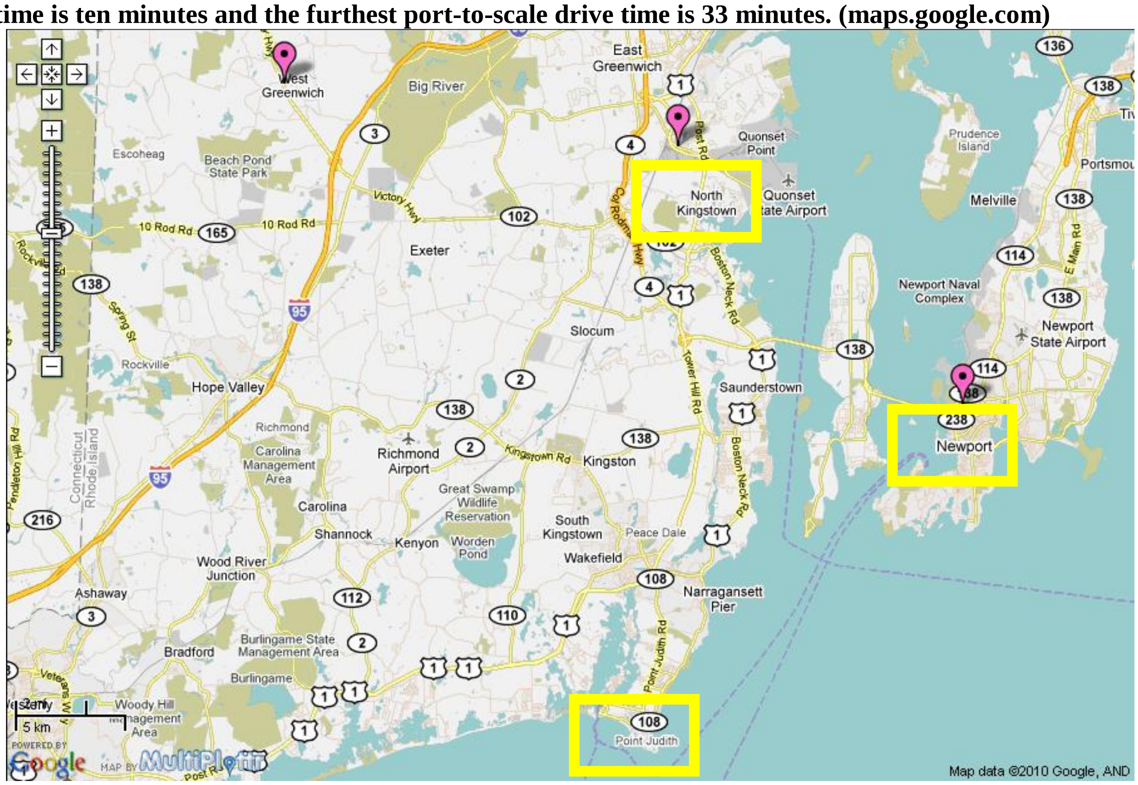

Figure 36. Existing truck scales in the Point Judith, Newport, and North Kingstown, RI areas, marked with violet markers. Yellow boxes indicate Communities of Interest (Amendment 5). The closest approximate port-to-scale drive time is less than five minutes and the furthest port-to-scale drive time is approximately 42 minutes (maps.google.com)

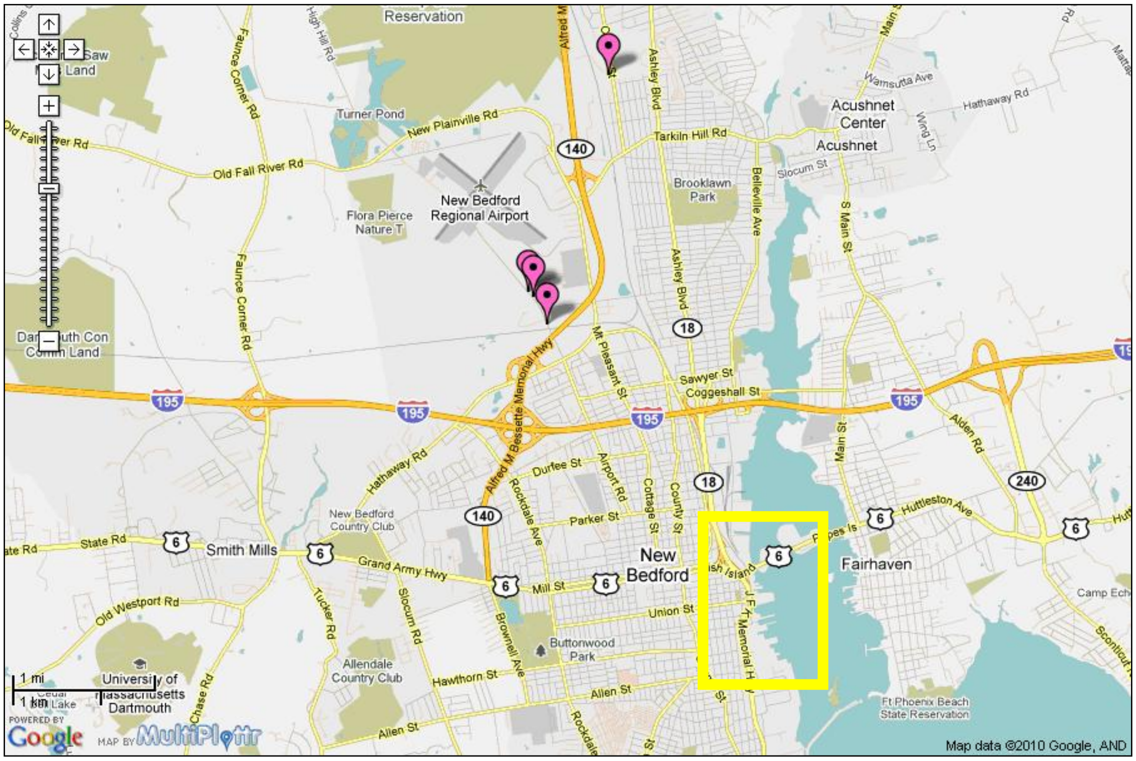

Figure 37. Existing truck scales in the New Bedford, MA area, marked with violet markers. Yellow box indicates a Community of Interest (Amendment 5). The closest approximate port-to-scale drive time is eight minutes and the furthest port-to-scale drive time is five minutes. (maps.google.com)

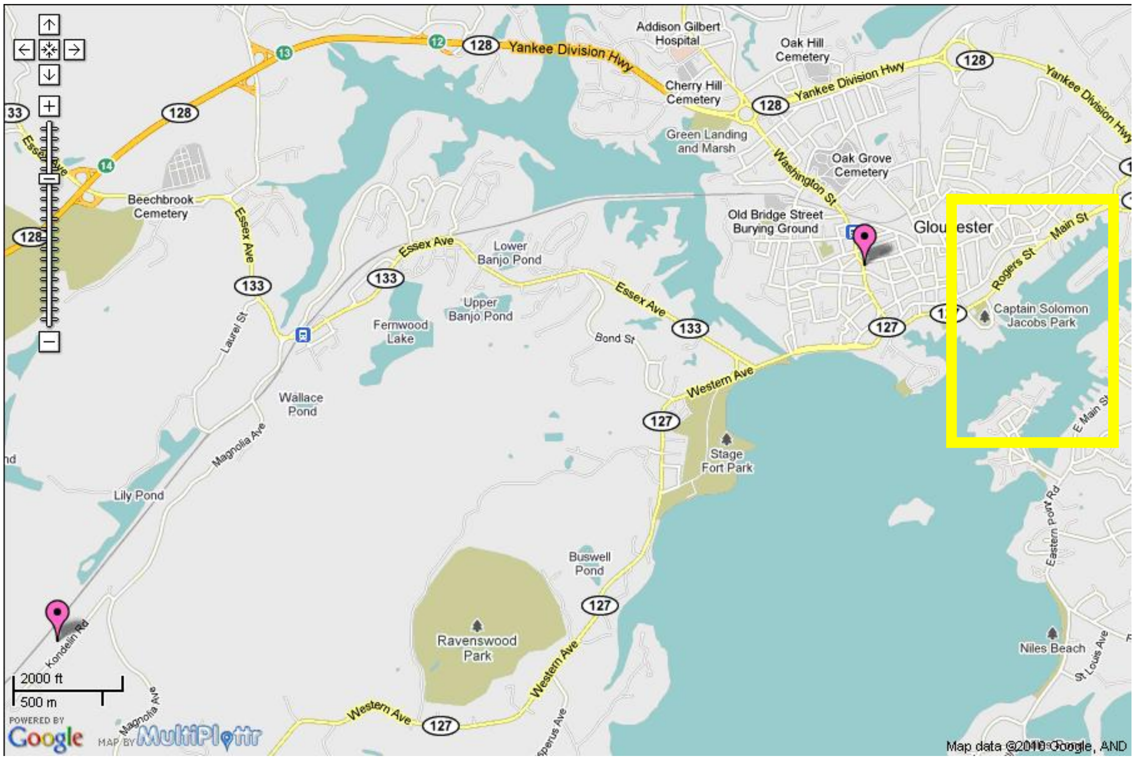

Figure 38. Existing truck scales in the Gloucester, MA area, marked with violet markers. The yellow box indicates a Community of Interest (Amendment 5). The closest approximate port-to-scale drive time is < 5 minutes, while the furthest is 11 minutes. (maps.google.com)

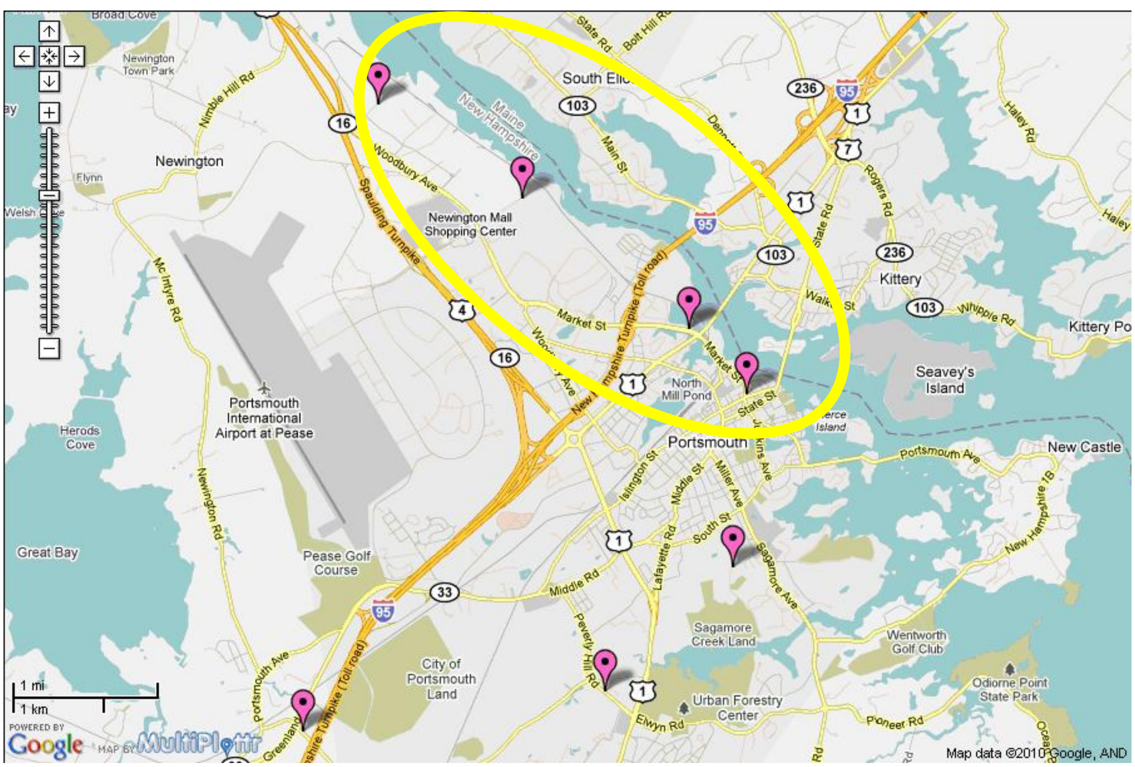

Figure 39. Existing truck scales in the Portsmouth, NH area, marked with violet markers. The yellow indicates a Community of Interest (Amendment 5). The shortest approximate port-to-scale drive time is less than five minutes, the while furthest is 11 minutes. (maps.google.com)

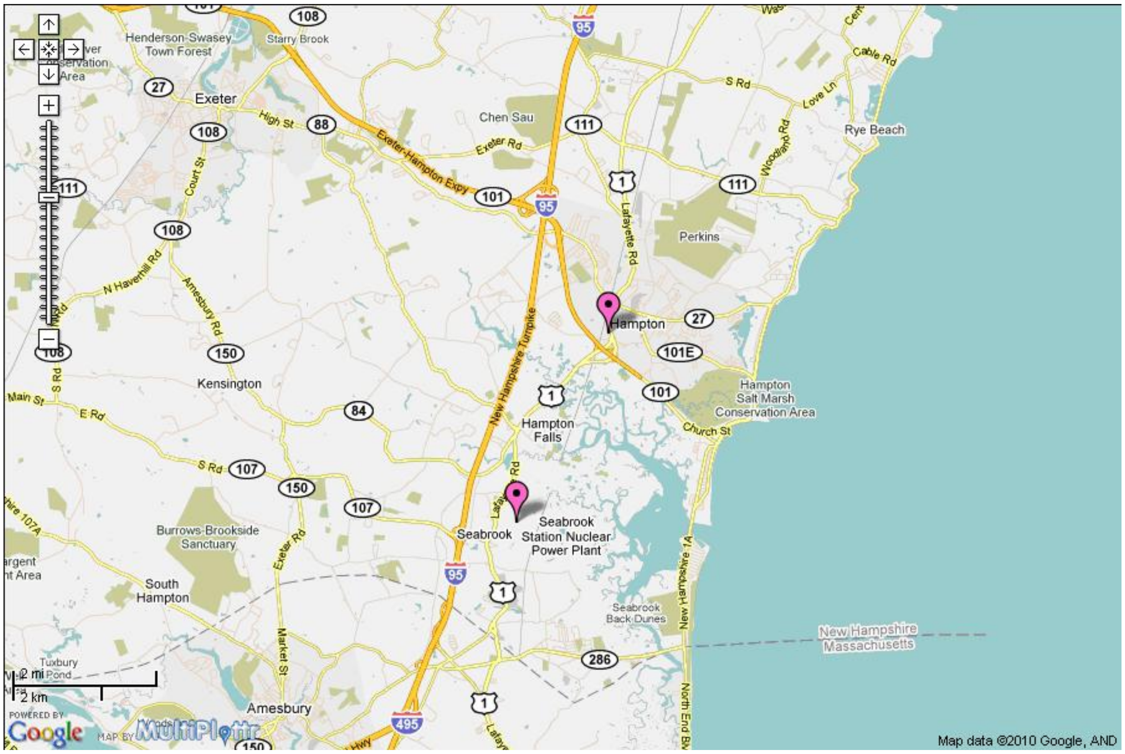
Figure 40. Existing truck scales in the Hampton/Seabrook, NH area, marked with violet markers, closest to the Communities of Interest (Amendment 5). The shortest approximate port-to-scale drive time is six minutes and the furthest port-to-scale drive time is 13 minutes. (maps.google.com)

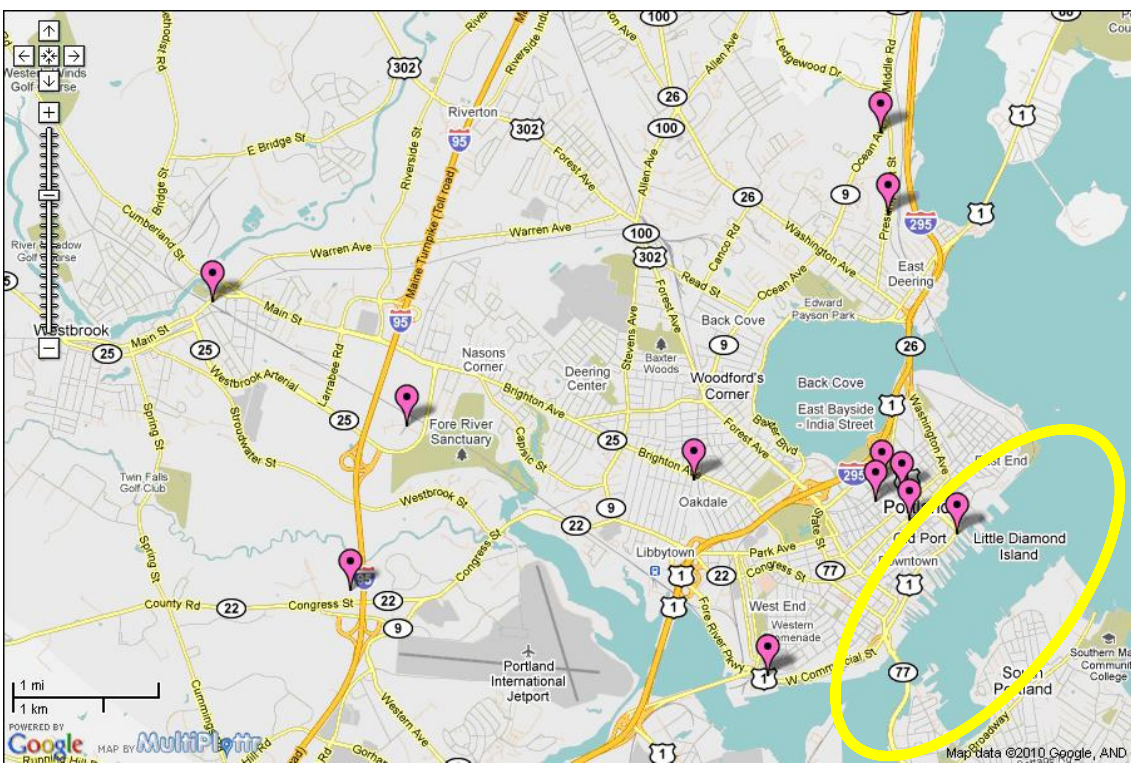
Figure 41. Existing truck scales in the Portland, ME area, marked with violet markers. The yellow indicates a Community of Interest (Amendment 5). The closest approximate port-to-scale drive time is less than five minutes and the furthest port-to-scale drive time is 15 minutes. (maps.google.com)

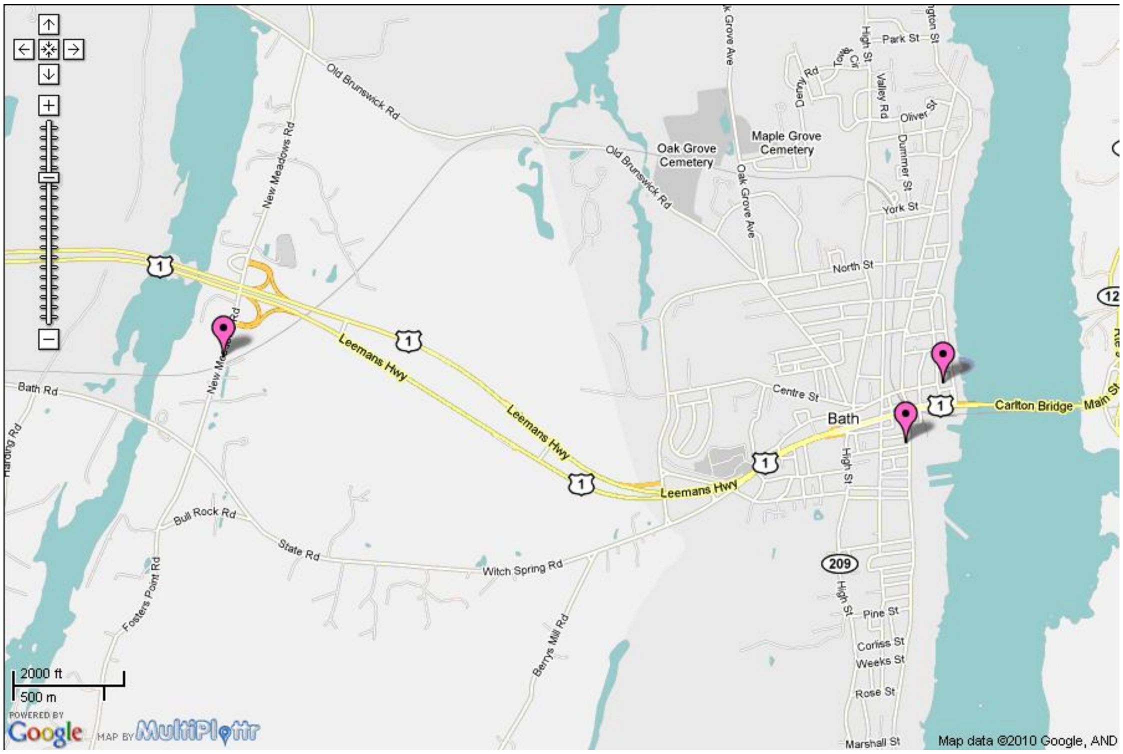

Figure 42. Existing truck scales in the Bath, ME area, marked with violet markers, closest to the Communities of Interest (Amendment 5). Both the shortest and longest approximate port-to-scale drive times are less than five minutes. (maps.google.com)

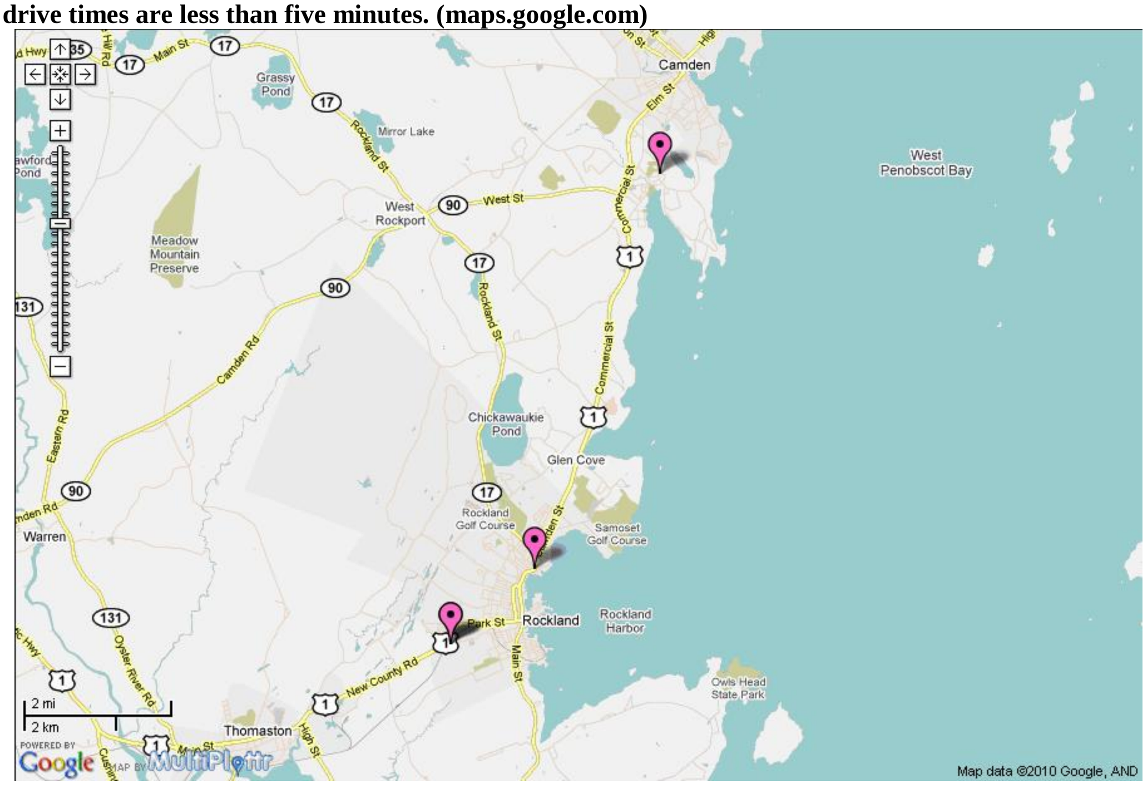

Figure 43. Existing truck scales in the Rockland area, marked with violet markers. Yellow boxes indicate Communities of Interest (Amendment 5). The closest port-to-scale drive time is approximately less than five minutes and the furthest port-to-scale drive time is approximately 11 minutes. (maps.google.com)

The other issue is the involvement of a third party. The company or organization which allows the scale to be used is neither the buyer nor the seller, but they will instantly be involved in the transaction. Legally, in order to issue a certified measured weight for payment for another party, the person issuing the information has to be licensed to print the ticket and give both parties a gross weight. This certification means that the slip of paper with the weight on it has to have an impression seal. Many of the scales in the range of the ports which land herring do not have a certified weigh master at their location around the clock, and the trucks could only be weighed at certain hours, which in turn could present a large hurdle for the buyers of herring. (Steve Giguere, Maine Dept. of Agriculture, Weights and Measures Inspections)

Another other option is place people such as portside samplers into these roles and train them to be certified weigh masters. The cost is $25 per person per year to be certified, plus any additional training. Harbormasters may be another group of people to train and have ready at different times in the day. The difficulty would still be availability of scales for the observers to operate and the cost of the observer or weigh master salary. (Steve Giguere, Maine Dept. of Agriculture, Weights and Measures Inspections)

Using existing scales could be an option, but it will require a lot of coordination and possibly extra driving for trucks and decreased quality for fish.

5.3 PORTABLE TRUCK SCALES

5.3.1 Large Portable Scales

There are two types of portable trucks scales. The first is a rather large scale, and is very similar to the fixed truck scales, as it comes in units of around 35 feet. The units can be disassembled and placed into a flat bed truck for transportation, but portability is an issue with such large pieces. The scale does require a power source. The cost is less than the permanent scales, as two units of 35 feet, for a total scale of 70 feet, average around $25,000 to $30,000.

There are a few major issues with the portable scales, in addition to the cost. Using a portable scale is very similar to using a fixed scale; the infrastructure around the scale has to be close to perfect in order to facilitate a correct measurement. Approaches and exit ramps must be built to specification around the scale, which typically require bulldozers or heavy machinery because the mounds have to be perfectly straight. If the mounds are not perfectly straight the truck will put uneven pressure on the scale and possibly break inner components. They must be installed in a non-muddy area and the ground must stay relatively dry, which may be difficult with a large amount of water leaving the trucks after pumping the fish. (All-Tech Weighing) The other disadvantage is that the scale cannot legally be left in place for more than six months, so if the Committee wanted to utilize one for a season to determine its effectiveness, the scale would likely have to be removed before the season ends. (Steve Giguere, Maine Dept. of Agriculture, Weights and Measures Inspections) There can also be issues with the calibration and sensors within the scale if the scale is taken over bumpy roads or for long amounts of time.

5.3.2 Wheel Pads

Figure 44. A wheel pad (photo credit: http://www.onboardscales.com/wheel-weigher-truck-1.htm)

The other form of portable scale is a very small and portable. Typically weighing around 40 pounds this scale operates on batteries and can come in either raised metal models or flat LCD models. The cost for the weigh pads is slight; between $2,200 and $5,000 per pad. No installation is required. The pads are used by driving onto a pad, one or two wheels at a time and tallying the weight on all of the wheels

The disadvantages of this scale is that accuracy range, particularly for larger, heavier vehicles, is so poor that the scale cannot be classified as legal for use in trade. That means that the weights that could be measured via these pads would not be able to be used for payment between herring seller and buyers. Within the scale industry these are only sold for law enforcement purposes.

5.3.3 Axle Pads

Figure 45. Axle pads (photo credit: http://truckscales.com/index2.htm)

Axel pads are very similar to wheel pads in that they are small and portable. The user drives the truck, two wheels at a time, onto the two axle pads. They are typically 7 feet long and have built in on and off ramps. This means that the area utilized for this scale do not require much more than a flat surface and an energy source, such as a generator. The cost for axle pads is around $13,000 for two.

Also similar to the wheel pads, these axle pads cannot be used for payment between sellers and buyers and are typically only sold for law enforcement purposes.

5.4 ACCOUNTING FOR ICE AND WATER

As was previously explained (Section 1.2), ice may or may not be used to keep fish cool when being transported. In considering all the three types of scales mentioned above it, will be important to factor in an uncertainty into estimates for ice and water, particularly if it is known that ice is being used in the truck. If a truck scale is used it is possible to weigh a truck when full of ice, then again when full of herring, and take the difference. Alternatively, the weight of the ice which is bought for the truck could be added to the pre-herring truck weight. On hot days, however, it is unlikely that the ice will not melt and therefore change the measurements accordingly.

In addition to the possibility of ice in the trucks, uncertainty in truck scale measurements should also be factored in for all catch due to water weight. Although most fish go through at least one de-watering box before entering the truck, not all the water will be removed. Even if the truck waits to drain all the water out of the trailer it is still possible for some of the weight to be attributed to water. (Industry Members, Personal Communication)

6.0 CERTIFIED VOLUMETRIC ESTIMATES

6.1 SEALING AND MEASUREMENTS

The State of Maine requires that all boats have their vessel holds measured (Section 7.1**Error! Reference source not found.**), and charges each boat based on the size and a rental fee. The cost is approximately $3 a hogshead up to 100 hogsheads, and is $1 a hogshead thereafter. There is also a cost of around $50 a day to rent the meter required to do the work. For a 100 hogshead boat this means the cost would be around $350.

The process of the certification needs to be understood to estimate how the program would work federally, however. In order to determine the volume, seawater is pumped into the hold using a 3 inch trash pump (a pump which is not hindered by objects in the water) to pump water through a mass flow meter. When the meter shows that 5 hogshead worth of water has been pumped into the hold, the process is stopped and a mark is made on the hold's wall to indicate where 5 hogshead is. This process is repeated over and over until the hold is full, then the water is drained and the marks made permanent. This allows anyone to lean into the hold, look at the side, and determine how much volume of fish exists.

The process can take a full day and more, depending on how large the hold is, and requires two men. Because the mass flow meter is very accurate, based on measurements of oscillations through a tube, and due to the difficulty in finding them, the cost of the mass flow meter is estimated to be between $20,000 and $25,000. Departments of weights and measures in other states may benefit from having this meter in their office, as it can pump many forms of solids and liquids, however between the cost of the meter and the cost of labor, this option would be expensive for the states if implemented. None of the states between New Jersey and New Hampshire had a flow meter available for use, and all recommended that the process be done by either the State of Maine or a federally qualified weigh-master.
(Steve Giguere, Maine Dept. of Agriculture, Weights and Measures Inspections)

An alternative to using the State of Maine for certification would be to use a Marine Surveyor. Most Marine Surveyors cost around $100 dollars an hour, plus travel and expenses. For a simple volumetric measurement and certification, using the dimensions of the hold, the cost could be estimated between $300 and $600, depending on the person employed. The accuracy of this method is questionable, however, as the holds are not always uniform or square. Use of a flow meter would likely produce a far better estimate of volume, as the water can adjust to the different shapes and sizes. The other issue with use of Marine Surveyors is the accreditation. Surveyors are not regulated, but there are a few accreditation societies. Some merely charge a fee, however, and require no testing or adherence to standards. While one option may be to require a certain form of equipment and a certain type of procedure, in certifying holds, the cost of equipment and procedure may serve to drive the cost of the certification up, and it may be cheaper and more accurate to question the integrity of the surveyor, rather than the equipment.
(Thomas Hill, Marine Surveyor)

To perform a similar process on a truck or container both would need to be certifiably sealed, to ensure that no water escapes. If either has a uniform bottom, however, it is relatively simple to use a tape measure to estimate volume, and convert that estimate to hogsheads.

Once the holds have been marked there is a method for achieving more accuracy than a visual confirmation. The concept is to take a heavy object that is lowered into the hold on a tape or pole and does not displace the water. The height of the water and fish is measured against the tape or pole, which can then be expanded to the entire volume using a table or graph. If the hold already has demarcation of the volume, then the volume can be checked visually
(Steve Giguere, Maine Dept. of Agriculture, Weights and Measures Inspections)

6.2 VOLUMETRIC UNIT CONVERSION

Another difficulty faced in volumetric measurement is units. One unit of hogshead can vary in interpretation. Conversion between units is also difficult with water involved; an average ought to be decided by the committee for converting a volume to a weight. In both Europe and Maine, where certified volumetric measurements are used, the conversion between volume and weight has been specified to avoid confusion, and has been for some time (see Appendix A for a historical document from Maine and Section 7.3 for discussion of the European regulations). Similarly, the State of Maine is currently working to determine how much weight there is per bushel of harvested menhaden. The Southeast Fisheries Science Center has been utilizing a “standard of fish” as its conversion factor in the menhaden fishery, and the units seem to work well; it was hypothesized that if a deck log on any given boat were to be surveyed that the sum of the at-sea estimates would come within a margin of 5% accuracy (See Appendix B for a historical documentation). The Committee may want to specify units of measurement used in certified volumetric measurements, if they are pursued. A table of units and their conversions can be found in Table 4.

		Volume		**Weight**		
	Unit	Cubic Meters	Bushels	Short Tons	Metric Tons	Pounds
State of Maine	Hogshead	0.62	17.50	0.61	0.56	1,225.00
European (Herring)	Herring Unit	100.00	28.38	90.39	82.00	180,780.00
European (Mackerel)	Makerel Unit	100.00	28.38	85.98	78.00	171,961.00
Southeast Science Center (Menhaden)	Standard Fish	0.36	10.23	0.34	0.30	670.00

Table 4. A table of conversions from volume to weight used at different times and locations

7.0 REGULATIONS REQUIRING WEIGHING OF FISH OR VOLUMETRIC MEASUREMENT

7.1 STATE OF MAINE

Regulations in the State of Maine already require that herring vessels have their fish holds measured and “sealed” by the State Sealer of Weights and Measures, so many vessels in the herring fishery already have the information necessary to determine the capacity of the fish holds. Relevant regulations from the State of Maine are summarized below.

- Sealing of boats. The holds of all boats transporting herring for processing purposes must be measured and sealed by the State Sealer of Weights and Measures or the State Sealer’s designee.
- Fee. The owner of the boat shall pay a fee for the measuring and sealing as determined by the State Sealer of Weights and Measures, based on the carrying capacity of the boat.
- Method of measuring and sealing. The measure must be in 5 hogshead divisions measured by liquid measure from a calibrated prover to the top of the hatch coaming. The measurement must be marked and permanently sealed, both forward and aft, in the hold, in the most practicable manner, while the boat is afloat.
- Notification of broken seals. The boat owner shall immediately notify the State Sealer of Weights and Measures of any alteration or the breaking of any seal.

- Certification to commissioner. After measuring and sealing each boat, the State Sealer of Weights and Measures shall certify to the commissioner the name of the owner and the name and capacity of each boat.

(Note: 1 hogshead = 17.5 bushels = 1,225 pounds)

7.2 FISHERIES OF THE EXCLUSIVE ECONOMIC ZONE OFF ALASKA

The equipment and operational requirements established by NMFS (§ 679.28 (Alaskan Fisheries) and § 680.23(Shellfish)) state that a vessel must have the on-board scale approved when initially installed and inspected by NMFS personnel each year thereafter (proved with a sticker and/or inspection report). In order to be approved, the scale make and model must be listed on a Regional Administrators list, and proof of initial laboratory testing must be provided, along with information about the specific scale. Custom hopper scales can be approved under certain qualifying conditions.

During annual inspections the responsibilities of the vessel owner are explained in the regulations. The vessel owner must also test the scale once daily and record specific information from the scale which is relevant to the test. The test itself is outlined in the regulations for each type of scale and for the weights used to conduct the test. The vessel owner must also perform regular maintenance and print reports daily. The reports have a list of required information such as pounds measured in a specific timeframe and basic vessel information and it is specified how long the reports need to be available and to whom. All weighed catch is reported. The scale cannot be installed where it may be bypassed easily and observers must be able to see that all catch is being passed through the scale.
(http://www.fakr.noaa.gov/regs/680/680b23.pdf;
http://www.fakr.noaa.gov/regs/679b28.pdf)

7.3 EUROPE

All E.U. and Norwegian-registered fishing vessels that carry their catch in refrigerated sea water (RSW) tanks are required to carry on-board calibrated volume tables for all of the fish tanks on the vessel. Those calibration tables must be checked and stamped by the member state under whose flag the vessel operates. The calibration tables are normally produced by the marine architect when the vessel is in the final stages of building; this will then be certified by inspectors from the fishery control of that state. In the case of a second-hand or converted vessel coming into the fishery, all the fish tanks have to be measured separately and calibrated by a competent marine architect, and again verified by an inspector. The calibration system works by measuring the entire volume of the tank to get its cubic capacity; the tank is measured in 10 cm increments, and this is scaled from the floor up to the edge of the hatch.

To actually measure the volume of fish in the tank, the fishery officer drops a small, flat steel weight about six inches square, connected to the end of a regular tape. When the weight falls through the water and settles on the fish, the officer then checks off the measurement against the hatch top. With this measurement, the officer can go to the calibration book for the vessel and calculate the cubic volume of fish in the tank. This process is then repeated on all the other tanks that contain fish, and the total cubic volume is calculated.

Because a cubic meter of fish does not equal a ton of fish, it was agreed with all control agencies in Europe and Norway that the following volume calculation values should be used:

- Herring per cubic meter x 0.82 (i.e., 100 cubic meters = 82 tons of herring)
- Mackerel per cubic meter x 0.78 (i.e., 100 cubic meters = 78 tons of mackerel)

This system has been in place for over 20 years and has been tried and tested many times, with total catches monitored and weighed in controlled conditions. It was always found to have an accuracy of between two and seven percent, depending on how accurate the person was when measuring. The vessels were originally allowed a discrepancy of 20% in what they declared and what the final result was, but this was found to be unnecessary. The discrepancy is now reduced to 10%, and both fishermen and control agencies feel comfortable working with this level.

7.4 CANADA

The Report on the Atlantic region dockside monitoring program and procedures for Fisheries and Oceans Canada (DFO) specify that Dockside Monitoring Companies (DMC) be established with a number of requirements. The policy establishes that the proper equipment must be available 24 hours a day and maintained via operational procedures and set requirements established by the individual DMCs. It also specifies that records of deployment of the Dockside Observers be readily available via databases or hard copies and that the information and data that is collected be protected under the provisions of the Privacy Act and maintained and archived for two and one-half years. Procedures are outlined for training observers, including demonstrating proficiency in "fish handling practices, off loading methods, and weigh-out methods and practices" and that Dockside Observers are trained in the weighing procedures that have been approved by the DFO. The duties of the Dockside Observer require that all dockside monitoring occur at a fish landing station, government wharf, or fish-buying wharf. All catch that is offloaded must be weighed and a clear line of sight from the boat to the scale must be maintained at all times. All boats must be checked after the offloading to certify that all catch has been removed, and the Dockside Observer can inform the off-loader that and all remaining fish be removed.
(http://www.dfo-mpo.gc.ca/communic/fish_man/ardmp/ardmp-pvqra_e.htm)

The Scope of the Fishing and Fish Products Sector Review, conducted by Measurement Canada, is in the process of establishing "an appropriate level of involvement for Measurement Canada in this industry to ensure measurement accuracy and equity" based on stakeholder review. Specifically the review will establish their role in regaurds to platform, hopper, crane and truck scales.
(http://www.strategis.gc.ca/eic/site/mc-mc.nsf/eng/lm00296.html)

8.0 SUMMARY

The regulations for the Canadian Dockside Monitors illustrates that while scales may be a useful addition to the herring fishery, it may be prudent to consider them in conjunction with dockside monitoring options in Amendment 5. Logically, any and all scales used to monitor the offloading of a vessel must be available at all times for those boats that must be monitored. Based on fisherman feedback, however, scenes of offloading tend to be complicated by multiple vessels offloading at one time, and care should be taken to avoid creating long backups for vessels which are returning. This may mean having multiple scales available at multiple ports if full scale coverage is required. If selective monitoring is chosen, then scales should be set up and ready to weigh as soon a vessel is ready to unload, to ensure the quality of the fish. Data collection, maintenance and quality should be assured though the monitoring program established. Likewise, once procedures for the chosen scales are established, observers will need to be trained in these procedures, including verification that the vessel is empty. Maintaining a clear line of sight between the vessel and the scale may be difficult, given the current setup of the ports for Atlantic Herring.

Depending on the scale that is decided upon, proper procedures for installation, maintenance, calibration, and re-certification should likely be established by the Committee. Based on multiple interviews it seems reasonable to assume that once a scale is decided upon, the vendor of the scale will be willing and able to help the Committee establish these procedures.

Flow Scales and Hopper Scales

In concept, flow scales have the potential to operate well in the herring fishery, however the speed at which they operate and the potential difficulties they can cause at sea make them less than desirable. Most importantly, the cost of such scales is so high that requiring their use would likely be prohibitive for the fishery. Hopper scales are more functional in the current operations, particularly if used on land. Similar to flow scales, however, the cost is prohibitive and implementing use in all ports or on all boats may not be desirable. Both flow scales and hopper scales are too large and permanent to be moved by portside or at-sea observers. Requirements to land all herring at certain ports may therefore become necessary, unless a frequency of sampling is determined which did not require 100% weighing of all catch. Most importantly, in the process described above (Section 1.2) it was illustrated that a decent amount of water tends to be left with the fish after the de-watering process has taken place. In both the hopper and the flow scales this could influence the recorded weight of the fish (however it may be different at processing plants).

If the Committee would like to utilize the Alaskan regulations, a list of approved scales could provide guidance for the boats purchasing scales and for the administrators who certify them. Conduct during the annual inspections could likewise provide guidance for all parties involved to increase the chances of a precise inspection. Daily tests, which could be specified more clearly once a scale is chosen, would likely also enhance accuracy of the data. The procedures to use and the variables to be produced by the test will depend on the type of scale chosen. All scales which have been reviewed for this discussion paper utilize computer reporting, and therefore would be able to produce a digital report. The required reports would also provide more accurate information regarding catch and the status of the scale. Placement of the scale onboard, however, would depend on the vessel. A requirement for certification of the scale upon initial installation and once a year thereafter would likely produce trustworthy data for the Northeast, particularly if overseen by NMFS personnel. The cost of the personnel in everything listed above is not determined, however, and would add to the already-prohibitive cost of the scales themselves.

Truck Scales

Similar to the flow and hopper scales, the cost of truck scales makes their applicability in management measures difficult. Both permanent and portable truck scales require a large portion of land, which not all ports have, as well as the ability to mold the land to fit the scale's requirements. The modifications to the land and surrounding structures would not only be costly, but require owners rights, which some ports used by the herring industry likely will not have. Moreover, the certification and operation of the scales would need to be done by licensed professionals, which would add an operating cost. NMFS certification of the data produced may also be prohibitive; there is no current arrangement with NMFS regarding trucks and transportation of fish off the water and similar to the flow and hopper scales, there would need to be compensation for the time and efforts of the employees involved in certifications or handling of data.

The use of existing truck scales may be of value for verifying the weight of fish. The cost of using such scales is low, and the locations are close enough to each port that it may be feasible to require trucks to stop on the way in and out. The time spent getting to the locations, both on the way in and way out, needs to be considered. On the way in the truck drivers will need to spend extra time getting to the facility and having the truck weighed. On the way out, the quality of the fish in the truck needs to be considered as well. While the time spent at the facility being weighed may be minimal, the time getting the truck onto the weighing pad properly plus the potential for long lines or other unforeseeable problems could increase the transportation time of the fish. In the summer and the warmer months, this extra time could cause the quality if the fish to be compromised. Alternatively, ice could be used to extend fish quality, but that could add extra time and costs for potential buyers or sellers.

Additionally, in order to be considered valid for commerce, a certified individual would need to do the weighing of the trucks at the facilities. Many of the facilities listed above do not have certified individuals weighing the trucks. Again, NMFS may have additional concerns with these certifications and with the use of some of the facilities as well. Verifying the quality of data may also be an issue, and again, there would need to be compensation for the time and efforts of the employees involved.

Certified Volumetric Measurements

Although the State of Maine is already conducting the procedure, the method used appears to be prohibitive or unaccepted for other state Departments of Weights and Measures. The cost per vessel may not be large, however the number of hours involved would be great for the Department of Weights and Measures, and further involvement from NMFS may be warranted for certification. One option would be to require the certification of all holds but without requirement of method; this would allow individuals to choose to travel to the State of Maine or use a Marine Surveyor. The cost of Marine Surveyors is high, however, and the question of certification of the measurements would also have to be raised. As was stated previously, the Surveyor hired would need to be approved or certified, likely by NMFS or another accredited organization. This option would cause those who live further from Maine to pay more than those who live close.

The method of 5 hogsheads divisions would be ideal to continue as those in the State of Maine who already have their vessels sealed and measured would not have to do so again. The measurement of 5 hogsheads is volumetric; the Committee would need to decide on a standard conversion from volume to weight for the information to be given in pounds, as was discussed in Section 6.2. Standardizing the location of the measurements, the certification process, and the notification of broken seals would most likely prove useful if the measurements are considered.

Overall, the relevancy of any of these measurements needs to be questioned. Application of the same rigorous standards as Europe has would likely produce more accurate information, however all boats in the fishery would need to be checked by a third party for every landing, such as a portside observer, which would increase cost. Although the volumetric measurement could aid captains estimates, the applicability of the information need to be determined. If the goal is to verify captains and dealer data from VTRs then who will stick the tank and when? What information would the committee hope to gain from such a measure, and at what cost? This measure would most likely be useful if portside samplers are utilized as a concurring measure in Amendment 5.

		Advantages	Disadvantages
Flow Scales		Designed for at-sea weigh-monitoring of fish	Cost: Between $50,000 - $80,000 a scale, plus maintenance fees
			Need for constant (almost daily) maintenance
			Potentially slower than existing pumping rate of fish
			Better suited to processing environments
Hopper Scales		Can be built to fit any situation and size	Cost: Between $35,000 and $60,000 a scale, depending on location
		Sturdy, simple, less maintenance than flow scales	Functions better on land
		Likely can keep up with pumping rate of fish	
Truck Scales			Overall difficulty for all truck scale: NMFS Certification
	Stationary	Can custom build (come in 20 ft increments)	Cost: Around $100,000 with install, depending on installation site
		Very accurate weighing	Permanent installation which requires land modification
			Potential for backup at scales on hot days (herring spoilage)
			Potentially would require Licensed Weigh Master
			Requires power source and possible small building
	Portable	Slightly Portable (requires flatbed)	Cost: Around 25,000-35,000 a scale, without installation
			Have to modify land to install
			Potential for backup at scales on hot days (herring spoilage)
			Potentially would require Licensed Weigh Master
			Requires power source and possible small building
			Can't stay in existing location for more than 6 months
	Existing	Cost: Between $5 and $10 for a weighing	Need to find 24 hour scales
			Need to have a Licensed Weigh Master
			More driving for some ports than others (herring spoilage in heat)
			4 communities of interest are not near existing scales
	Axle and Wheel Pads	Cost: Between $2,200 and 13,000	Not legal for tender (law enforcement only)
		Very portable	Frowned upon by Weigh Masters
			Some require power source
Volumetrics		Cost: Around $350 per vessel	Need to travel to Maine or use more expensive Marine Surveyor
		"Sticking" of vessel is a simple estimation method	Need to agree upon volume -> weight conversion
			Cost/Benefit tradeoff: still an estimation

Table 5. This table presents a summary of the advantages and disadvantages discussed in this document.

9.0 APPENDIX A

(Unpublished, SEFSC in-house document)

VERIFICATION OF MENHADEN CONVERSION FACTOR

Introduction

A preliminary report submitted about 4 months ago stated that the total weight of menhaden per standard "quarter-box" dump of 22,000 cu.in. averages closer to 530 pounds than to the traditionally recognized 667. The lower value was obtained by projecting (from 84 trials) the total weights of fish in a sampling container measuring slightly less than one twenty-third the capacity of the industry's standard dump. Subsequent observations revealed, however, that such procedure fails to allow for the added and sizeable effect of compactness, a factor erroneously assumed negligible during the initial investigation. This report briefly summarizes the findings of a followup study in which the capacity of the sampling container more closely approached that of the standard dump, yet was not so great that the filled container proved too unwieldy when making the desired measurements.

Procedure

In the followup study Bureau personnel used a common "32-gal." steel trash can with a verified capacity of 32.4 gal., or 7,484 cu. in., very close to one-third the volume of the standard fish-measuring dump mentioned above. An additional feature of this container was its height, which approximated the depth of the standard dump and thereby helped to overcome most of the bias attributable to expected differences in compactness between fish weighed in the container and those filling a dump.

All told, we obtained the weights of 33 containers-full of fish. These samples consisted mainly of fresh fish 6 to 12 in. long taken from the "raw boxes" of five different reduction plants. They were distributed in time and space as follows:

Month	Port	Number
September	Fernandina Beach, Fla.	1
	Southport, N. C.	1
	Beaufort, N. C.	2
	Reedville, Va.	4
October	Moss Point, Miss.	3
	Fernandina Beach, Fla.	1
	Beaufort, N. C.	7
	Reedville, Va.	8
November	Beaufort, N. C.	4
December	Beaufort, N. C.	2

After their calculation, the net weights of fish in each sample were projected by the appropriate factor (2.94) to the estimated weights of fish of the same size and condition that would occupy a volume of 22,000 cu. in.

Findings

The 33 sample estimates yielded a mean value of 667.6 pounds (per 22,000 cu. in.)--remarkably close to the hypothesized 666.7. The sample standard deviation of 24.6 pounds, when expressed as a fraction of the sample mean, corresponded to a coefficient of variation of only 3.7 percent, which indicates a high degree of sample reliability. Mere inspection of these results was sufficient to establish the lack of a statistically significant difference between the hypothesized and estimated weights of menhaden per standard "quarter-box" dump.

Further examination of the sampling data disclosed that the principal source of variation in weight per standard dump is fish spoilage. In the half dozen situations where the sampled fish had to be classed as "very soft" because of advanced decay and gross deformation, the projected weights per dump consistently exceeded the estimated mean by large amounts. Significant effects of differences in average fish size or condition could not be demonstrated.

Summary

Having been verified statistically, the factor 0.667--or 0.67, whichever is more convenient--should now be affirmed as the official standard for converting to weight all landings of menhaden measured volumetrically in "quarter-box" dumps and reported by the industry in terms of thousand-fish units (i.e., 1,000 "standard" fish weigh on the average, 667 pounds or one-third short ton).

As suggested in the preliminary study, the same factor should also be used to convert landings reported in thousand-fish units by plants that employ continuous weighing machines. It will be recalled that such machines are calibrated to tally a thousand-fish unit with the passage of every 755 pounds. The 88-pound weight difference has been attributed to additional water, dirt, and slime that adhere to the fish as they are pumped from the vessel with recycled water, and therefore does not have to be taken into consideration when making the conversion. The propriety of this add-on will be checked as circumstances permit.

JHK
1-26-66

10.0 APPENDIX B

SEAPRO INCORPORATED

Manufacturer of Fish Meal and Fish Oil

ROCKLAND, MAINE 04841

Phone Rockland 594-7100 or Camden 236-3810

HERRING MEASURE — CONVERSION CHART

Bushels	Hogsheads	Tons
17.5	1	.6125
35.0	2	1.2250
52.5	3	1.8375
70.0	4	2.4500
87.5	5	3.0625
105.0	6	3.6750
122.5	7	4.2875
140.0	8	4.9000
157.5	9	5.5125
175.0	10	6.1250
192.5	11	6.7375
210.0	12	7.3500
227.5	13	7.9625
245.0	14	8.5750
262.5	15	9.1875
280.0	16	9.8000
297.5	17	10.4125
315.0	18	11.0250
332.5	19	11.6375
350.0	20	12.2500
367.5	21	12.8625
385.0	22	13.4750
402.5	23	14.0875
420.0	24	14.7000
437.5	25	15.3125
455.0	26	15.9250
472.5	27	16.5375
490.0	28	17.1500
507.5	29	17.7625
525.0	30	18.3750
542.5	31	18.9875
560.0	32	19.6000
577.5	33	20.2125
595.0	34	20.8250
612.5	35	21.4375
630.0	36	22.0500
647.0	37	22.6625
665.0	38	23.2750
682.5	39	23.8875
700.0	40	24.5000
717.5	41	25.1125
735.0	42	25.7250
752.5	43	26.3375
770.0	44	26.9500
787.5	45	27.5625
805.0	46	28.1750
822.5	47	28.7875
840.0	48	29.4000
857.5	49	30.0125
875.0	50	30.6250
892.5	51	31.2375
910.0	52	31.8500

Bushels	Hogsheads	Tons
927.5	53	32.4625
945.0	54	33.0750
962.5	55	33.6875
980.0	56	34.3000
997.5	57	34.9125
1015.0	58	35.5250
1032.5	59	36.1375
1050.0	60	36.7500
1067.5	61	37.3625
1085.0	62	37.9750
1102.5	63	38.5875
1120.0	64	39.2000
1137.5	65	39.8125
1155.0	66	40.4250
1172.5	67	41.0375
1190.0	68	41.6500
1207.5	69	42.2625
1225.0	70	42.8750
1242.5	71	43.4875
1260.0	72	44.1000
1277.5	73	44.7125
1295.0	74	45.3250
1312.5	75	45.9375
1330.0	76	46.5500
1347.5	77	47.1625
1365.0	78	47.7750
1382.5	79	48.3875
1400.0	80	49.0000
1417.5	81	49.6125
1435.0	82	50.2250
1452.5	83	50.8375
1470.0	84	51.4500
1487.5	85	52.0625
1505.0	86	52.6750
1522.5	87	53.2875
1540.0	88	53.9000
1557.5	89	54.5125
1575.0	90	55.1250
1592.5	91	55.7375
1610.0	92	56.3500
1627.5	93	56.9625
1645.0	94	57.5750
1662.5	95	58.1875
1680.0	96	58.8000
1697.5	97	59.4125
1715.0	98	60.0250
1732.5	99	60.6375
1750.0	100	61.2500

DATA

1 Bushel Herring—70# 27 Cu. ft. = 1 cu yd.
1 Cubic Foot Herring—56.2#
1.244 Cubic Feet Herring—1 Bushel = 70 lbs.
21.77 Cubic Feet Herring—1 Hogshead
28.56 Bushels Herring—1 Ton
1225#—1 Hogshead
17½ Bushels—1 Hogshead

SEAPRO INCORPORATED
Rockland Maine

162.8 gals = 1 hogshead