Primary Processor Scombrotoxin Controls – Harvest Vessel Records

We introduced you to the hazard of scombrotoxin formation in vulnerable species of finfish in a companion video titled Primary Processor Scombrotoxin Controls – Overview and Testing at Receiving. This hazard results from bacterial activity that occurs under abusive time and temperature conditions after the fish dies, and, if not controlled, can cause scombrotoxin poisoning in consumers.

Harvesters are always the first, and often the most critical link in preventing scombrotoxin formation. While fishermen are exempt from the seafood HACCP regulation, primary processors, who are generally the processors that off-load fish from the harvest vessels, are required to take steps to ensure that the fish they receive and introduce into commerce have been harvested and handled in a way that prevents scombrotoxin formation and are safe for consumption.

In the companion scombrotoxin control video, we introduced two strategies recommended by FDA for primary processors to prevent scombrotoxin formation at the receiving critical control point – the Harvest Vessel Record Control Strategy and the Histamine Testing Control Strategy.

The Histamine Testing Control Strategy was covered in the companion video, as were recommended receiving controls involving internal temperature measurements and sensory examinations, which are applicable to both the Histamine Testing Control Strategy and the Harvest Vessel Records Control Strategy.

In the Harvest Vessel Records Control Strategy, the primary processor receives recorded observations made by the vessel operators to demonstrate that the fish were harvested, handled, and stored aboard the boat in a manner that prevents scombrotoxin formation. This video focuses on your efforts as the primary processor in getting meaningful harvest vessel records from the fishermen.

Let's first look at the onboard chilling parameters that will effectively prevent scombrotoxin formation.

During harvest, fish should be chilled and packed in ice or other appropriate chilling medium, such as refrigerated seawater or an ice slurry, as quickly as possible after the fish dies. This keeps the fish from decomposing and prevents bacteria from forming scombrotoxin. FDA recommends the following time restrictions to get dead fish into chilling media of 40 degrees Fahrenheit or less.

Think in terms of time limits of 6, 9, or 12 hours. Generally, whole, uneviscerated fish should be placed into the chilling medium not more than 9 hours after the fish dies.

The time limit is shortened when either the water or air temperature are high because it takes longer to chill the fish and scombrotoxin forms more rapidly at higher temperatures. Therefore, when either the water or air temperature is above 83 degrees Fahrenheit, the fish should be placed in the chilling medium within 6 hours after the fish dies.

Removing the gills and guts of the fish and carefully cleaning the gut cavity eliminates a significant portion of the bacteria that cause scombrotoxin formation. When fishermen gill and gut, the fish can safely be held longer before chilling, but should be placed in the chilling medium within 12 hours after the fish dies.

These recommended time-to-chill limits rely on the fishermen knowing when the fish died. Time of death is readily apparent when fish are captured alive and slaughtered aboard the fishing vessel. But, sometimes fish will die in the water before being brought aboard, meaning the fishermen will not know the precise time of death. This often happens when the fishermen use gill nets, trawls, longlines, and seines. In these cases, the fishermen will have to estimate when the fish died. The estimated time of death should be based on the first possible moment the fish could have died, but should be something that can be reliably observed or measured, and recorded. In some cases, the only reliable estimate is when the fishing gear is first deployed – for example, the time a longliner deploys the first hook into the water, because this is the first moment a fish could be hooked and die. Fishermen should then use this estimated time of death in applying the recommended time-to-chill limitations. So, for example, a trawler operating in air or water temperatures above 83 degrees should ensure that the uneviscerated fish from any trawl set are all sorted and in the hold on ice within 6 hours of the time the trawl is fully deployed and beginning to catch fish, not the time the dead fish are brought aboard.

There's an exception to using the time of death or estimated time of death as a safe monitoring criterion when harvesting dead fish. The exception applies when the water being fished is 65 degrees Fahrenheit or less. FDA studies indicate that scombrotoxin formation is delayed or slowed for up to 24 hours in fish that are dead in the water that never exceed 65 degrees. If the fishermen can measure and document that the water temperature for each set never exceeded 65 degrees at the depth where fish are captured, die, and remain until harvested, and that the fish are recovered within 24 hours of death or estimated time of death, then the fishermen can apply the recommended time-to-chill limits beginning with the time when the fish first leave the cool water. For example, a longline harvester that measures the water at hook depth to be below 65 degrees and begins hauling back within 24 hours of first beginning deployment of the line, could apply the time-to-chill limits when haul-back of the line begins. This exception does not apply if seawater temperatures are above 65 degrees or if the time to recover the fish is more than 24 hours. And fishermen should reliably measure and record actual seawater temperatures for each set. They should not assume or estimate seawater temperature. The same 6, 9, or 12 hour time-to-chill criteria previously described can then be applied and measured from when the fish leaves the cold 65 degree water. Such things as the air temperature and whether or not the fish are eviscerated before chilling will need to be considered to determine which time limit applies.

In all of the time-to-chill situations just described, fish should continue to be cooled down as rapidly as possible to reach an internal temperature of 40 degrees Fahrenheit or below and all of the fish should be retained by the harvester at 40 degrees or below throughout the remainder of the fishing trip until off-loading.

In addition to the time and temperature criteria, there are some other onboard handling control issues you may potentially need to address.

Some fishermen will land both live and dead fish in the same set. You cannot apply the recommended time-to-chill limits as if all the fish are landed alive and ignore the fish landed dead. If fishermen's handling practices and records do not distinguish between live and dead-landed fish, you should use the earliest time of death estimate for each set in the vessel lot.

Also, gilling and gutting shortly after the fish die can effectively reduce the number of bacteria that can cause scombrotoxin to form in the fish. But, if not done carefully, it can actually become a disadvantage. Make sure your fishermen eviscerate with care to avoid spreading scombrotoxin-forming bacteria from the gills and guts to the fish muscle and the rest of the catch.

In addition, some of the controls used on the vessel may make use of thermometers or other temperature measuring devices, such as when measuring sea and air temperatures, monitoring the temperature of brine chilling tanks, or if other fish or environment temperature measurements are included as part of the onboard scombrotoxin controls. Any temperature monitoring devices used aboard the vessel should be safe and appropriate for food products.

Also, when figuring out how often to measure temperatures or to check for the adequacy of ice, such as in chilling tanks or during onboard storage of the fish, consider environmental conditions, such as air and water temperatures to which the fish are exposed during the operation, the initial temperature of the fish themselves, the effectiveness of the chilling method, and how well the hold is insulated. Practices such as the type of ice used, the ice-to-fish ratio used, or the volume of fish passing through the ice slurry chilling tank are the types of things that can affect the frequency of monitoring that needs to occur.

Now that we've talked some about the onboard parameters that will prevent scombrotoxin formation, let's take a closer look at how you can implement the harvest vessel record control strategy to ensure the fish you off-load from the vessels are safe. But don't forget, in addition to receiving harvest vessel records, you should be checking the fish you off-load for decomposition and internal temperatures as we discussed in the companion video.

For the harvest vessel record component of this HACCP strategy, the appropriate critical limit is the receipt of records that show that the onboard controls to chill the fish in a timely manner and hold them in a chilled state throughout the fishing trip were met for all of the fish in the vessel lot. Thus, the critical limit in your HACCP plan should also specify the time and temperature chilling parameters expected to be met onboard the vessel. These parameters should generally be consistent with the 6, 9, and 12-hour time-to-chill recommendations previously presented.

Monitoring procedures for this critical limit, should not simply ensure that a record is provided by the harvester but should also include a careful review of the record to ensure it has all the appropriate data and information necessary and shows that your chilling and onboard storage critical limit controls were, in fact, met.

FDA recommends several elements that you might want to make sure are included in your harvest vessel records as they apply to your specific operation.

Your records may include information such as the fishing method used to harvest the fish, the time the fish die or the observations used in determining the estimated time of death, air and seawater temperature during harvest and aboard the fishing vessel, the temperature at the depth of catch if applicable, the time the fish are landed on the vessel, how the fishermen chilled the fish, when the fishermen began to chill each fish and/or finished chilling fish from a particular set, and the monitored conditions under which the fish are stored during the duration of the fishing trip. You may need to adjust this list by deleting or adding elements to best capture the controls needed in your specific operation. For example, if gilling and gutting is an important part of your operation's controls, you will want to include that element in your records. This list should not be viewed literally as much as to represent some ideas of the kinds of information that you will need to think about obtaining from the fishermen while you are developing an appropriate monitoring record for your operation.

Some of the information you will want to document may not change from fishing trip to fishing trip within your operation; for example, the method of harvest or the method of chilling or storage. These constant or fixed elements can be included as part of the record form rather than as something the fishermen must enter themselves each time they fish.

Let's look at some example records to see how the needed information can be assembled.

Here's an example of a harvest vessel record completed by a troller. The fixed elements of this record show that the method of capture is by trolling, that the vessel will be landing live fish, that the temperature exposures are assumed to exceed 83 degrees Fahrenheit, that the fish are not eviscerated onboard, and that the fish are cooled and stored by packing them in ice. Before any information is recorded by the fisherman, the record provides a good deal of information about the onboard processes. Based on this information, FDA recommends that the fisherman should get the fish iced within 6 hours of death. Since the fish are landed alive, this means icing within 6 hours of being landed on the boat deck. Your HACCP plan should include this 6 hour limit as part of your critical limit for the receiving critical control point.

The fisherman in this example lands individual live fish periodically over the course of the day, but recording times of landing and chilling each individual fish caught would be cumbersome. So, the fisherman divides the catch into groups or series of fishing periods that are no more than 6 hours each. The fisherman documents the time the first fish of each series is landed and the time the last fish in the series is iced and in the hold. If the time between the landing of the first fish and icing of the last fish in each series is within 6 hours, then the fisherman will have met the 6-hour time-to-chill critical limit requirement. While this information provides assurance that scombrotoxin formation is prevented, most quality conscious processors and fishermen don't want fish left on the deck for 6 hours. To address this, note that the processor includes operating instructions on the harvest vessel record form that go beyond the necessary critical limit parameters. The processor instructs the fisherman to get each fish iced and in the hold within 20 minutes of landing the fish, which is standard practice for this type of fishing operation. There's no harm in including these types of operation instructions on the record form.

You'll also want assurances that the chilled fish remained cold throughout the fishing trip by including a critical limit in your HACCP plan requiring that the stowed fish remain completely surrounded by ice. This troller is instructed to check the fish at least every 12 hours and is reflected in the recordkeeping. Some processors might also ask the fisherman to identify where in the hold each series is stowed. This information gives the processor more flexibility in deciding whether to accept or reject portions of the vessel lot if anything goes wrong in a particular series. For example, the processor can reject those fish from a suspect fishing series while accepting fish from the other series that were handled and chilled within the critical limits rather than rejecting all of the fish on the vessel.

Next, let's look at a record designed for a trawler. In this operation, the fish are packed on ice uneviscerated. That means that either the six or nine hour time-to-chill limit applies, depending on seawater and air temperatures during the catch. The processor has chosen not to be concerned with which time limit applies, because a typical trawl set takes less than three hours, well within the shorter 6-hour time limit recommended. This processor has developed a harvest vessel record form that minimizes the fishermen's recordkeeping. The fishermen record the time the trawl for each set is fully deployed, the time the last fish from each trawl set is safely stowed on ice, and the time that periodic checks for the adequacy of ice surrounding the fish in the hold are done. Less information gathering

makes recordkeeping easier for all involved; but it can have pitfalls. The minimal data approach could hurt this processor and the vessel's crew if something were to go wrong.

Here's an example. Notice that the fisherman appropriately recorded a delay due to a snagged net during set number eleven. Here, the fisherman repaired the disabled gear and resumed fishing before the catch from the disrupted set was stowed on ice. Unfortunately, the exposure time for the affected fish was seven hours from the earliest estimated time of death to the time the last fish of the set was placed in the hold on ice. This exceeded the maximum recommended exposure of six hours for uneviscerated fish when temperatures of the air and sea exceed 83 degrees Fahrenheit. So the processor is faced with several problems due to the limited information provided on the record. First, if the processor had asked for sea and air temperature measurements and found that the actual exposures were below 83 degrees Fahrenheit, he would have determined that the recommended exposures at the cooler temperatures allowed him to extend the safe exposure time to nine hours. The seven-hour-exposed fish might have been deemed safe if he knew for a fact that the temperatures were below 83 degrees Fahrenheit, but without the measurements and records, he could not make that assumption.

The processor is further disadvantaged because the portion of the lot containing the affected fish from set eleven cannot be differentiated from any of the other fish from that vessel in that particular delivery. If the fisherman had isolated the affected fish from set eleven in the hold and recorded that fact or if the processor had required records showing where each fish from each trawl set were stowed, the processor could have accepted unaffected fish from other locations in the hold. In that case, corrective action would be limited to the small portion of affected fish in isolation. However, without the recorded information, he has no means of isolating only the affected portion with any certainty, rendering the entire vessel lot suspect and a risk.

Let's turn to a more complex record, one for a longliner. Longliners can present a unique challenge to ensure all fish introduced into commerce from these vessels are safe. This is because of the long time some fish that die on the line may be exposed to warm seawater before being hauled in and brought aboard. Over the course of many hours, a longliner will deploy a line containing numerous hooks, oftentimes many miles long; then, wait for a time to allow the line to hook fish, a period commonly known as a soak; and finally, haul back the line and land any fish caught. The fish are often eviscerated, washed, chilled, and stowed, as they are individually retrieved during the line haul-back. A complete commercial longline set, from beginning of deployment to last fish iced, can take up to 15 hours or more. And, because some of the fish brought aboard will have died in the sea at some unknown time after being hooked, much more than the 6, 9, or 12-hour time limitations recommended by FDA for ensuring delivery of safe fish may have passed. Nevertheless, well-conceived recordkeeping of a small number of easily monitored points during each set can overcome the challenges that may be posed for longline operations.

Here's an example of a longliner harvest vessel record. The fixed elements show that the method of capture is by longline which results in the landing of both live and dead fish. The sea exposure temperatures are assumed to exceed 65 degrees Fahrenheit, that fish are gilled and gutted onboard, and that the longliner initially chills the fish in an ice slurry before packing them in ice in the hold. As the primary processor, you will be looking for data from the fisherman that ensures that the gilled and gutted fish delivered were all in the chilling medium within 12 hours of the time of death of the fish as recommended by FDA under these conditions.

Longlining presents no exceptional difficulty in recordkeeping for fish that are landed alive. The live fish don't die until landed on the vessel, and the fish aren't landed on the vessel until haul-back of the longline begins. Each individual fish is immediately gilled, gutted, rinsed, and placed in the ice slurry as it's landed on the vessel. Typically, the fishermen take only 10 to 15 minutes to prep each fish and get it into the ice slurry. Unless something goes wrong with the haul-back, the longliners that this processor buys from usually take approximately 4 hours to haul back the line. So, to ensure that the formation of scombrotoxin was prevented in the fish landed alive, the processor really only needs assurances that the time from the beginning of the haul-back until the time the last fish from the set is gilled, gutted, and in the ice slurry at the end of the haul-back took less than 12 hours.

In this example, the fisherman records the time the haul-back begins and the time the haul-back is completed with the last fish in the ice slurry. The processor can use this information to calculate the total time lapse from haul-back and fish handling of each set when the record is submitted at delivery. As long as the entire time lapse was less than 12 hours, the fish landed alive in any given set should be safe. The record also documents the fisherman's observations that, in general terms, individual fish were gilled, gutted, and placed in ice slurry within one hour of landing. This serves a dual purpose. It ensures that fish are not left lying on the deck needlessly during haul-back and, more importantly, that all fish are gilled and gutted prior to chilling which is a critical component of the 12-hour control limit.

Fish that are landed on the boat dead present a different safety and recordkeeping challenge. These fish may have had the opportunity to form scombrotoxin while dead in the sea and prior to landing and handling on the vessel. Fish that are landed on the vessel dead could have died just before it was hauled up or the fish may have been hooked and died shortly after the first hook of the set hit the water, or anything in between. Unless the longliner uses expensive sensors on every hook the fisherman cannot know with certainty when each individual fish died at sea. Consequently, you and the fisherman need to assume the worst case scenario and make decisions on the information that can be actually observed and recorded. Here, the only certain measurement that the longliner can observe is the time it begins to deploy the longline, when the first baited hook enters the water with the potential for an immediate fish strike. So, the beginning of deployment begins the clock to establish the earliest estimated time of death for the fish that are subsequently landed dead in the set. The processor's next step is to figure out when to stop the clock.

This processor's longline suppliers typically take 3 to 4 hours to deploy the longline, then allow a 6 hour soak, followed by another 3 to 5 hours to haul back the line, depending on the number of fish caught. Because the entire time period for the set can typically take 12 to 15 hours or more, simply measuring the lapsed time from the beginning of deployment to when the last fish of the set is in the ice slurry, will nearly always exceed the 12-hour critical limit that ensures the fish are safe for consumption. But by breaking down the lengthy time period into manageable segments, the longliner can provide adequate assurances. The fisherman begins retrieving the longline from the same end as originally deployed. In this way, the first hook in the water with the potential for the earliest possible fish strike is also the first hook retrieved from the water. By documenting that it takes less than 11 hours from the time the longline deployment began to the time the haul-back began, allowing an extra hour for the fish to be butchered and placed into the chilling medium, the longliner can show that a fish landed dead as early as the first hook will have met your 12-hour critical limit and should be safe.

Moreover, it typically takes a longliner at least as long to haul back the line as it did to deploy it. Looking at the record, you can reasonably assume that if the time lapse from the end of deployment to the time that the line is fully hauled back and the last fish is in the ice slurry is also less than 12 hours, then each

hook that deployed would have been retrieved within the 12-hour period and all of the dead-landed fish from that set should be safe. If either of these conditions, either 11 hours from beginning of deployment to beginning of haul-back or 12 hours from end of deployment to end of haul-back and last fish in chilling medium is not met, then the fish landed dead in that set are suspect and subject to corrective action, such as rejection or histamine testing.

To distinguish between live-landed and dead-landed fish, the primary processor requires the longliner to tag and number each fish landed dead. This allows the processor to make separate accept or reject decisions about fish landed alive and dead, and, if needed, to confine corrective actions such as rejections to suspect fish from affected sets. This processor also instructs the fishermen to identify the specific bins where fish from each set are stowed. This allows the processor to make accept or reject decisions for both live and dead-landed fish from each set without risking loss of the entire vessel lot.

The longliner provides the processor with an additional record to show that the ice slurries used for initially chilling fish from each set were maintained adequately during each haul-back and that the fish were properly maintained iced in the hold for the duration of the trip. Monitoring the ice slurry initially and at least every two hours during each haul-back ensures that the chilling effectiveness is maintained and that ice will be added before scombrotoxin can begin to form in the exposed fish.

The processor also instructs the fishermen to check the adequacy of ice surrounding the fish stored in the hold every 12 hours. The processor set the frequency of these checks based upon icing practices and insulation properties of the vessels he off-loads. But you need to recognize that a problem discovered 12 hours after the last check automatically makes the affected fish suspect for scombrotoxin. Environmental or onboard conditions conducive to more rapid ice melt may favor more frequent checks. Checks every 4 hours or less provide better opportunities for the fisherman to take corrective action before scombrotoxin has the opportunity to form. Notice that the record allows the fisherman to show specific sets or bins affected by insufficient ice so that the processor again has the ability to make selective accept-reject decisions on portions of the lot rather than the entire lot as a whole.

In the same way that you must conduct a careful hazard analysis and develop a HACCP plan tailored to your own processing operations, you should carefully analyze and tailor harvest vessel records to your particular fishing operations. Applicable elements to be fixed on the record form and those that will be observed and recorded must be given serious strategic thought to ensure the best outcome for the fishermen and yourself. In most cases, the fishermen or vessel operators perform the recordkeeping because they're the only ones who can make first-hand observations of the activities to be recorded. It's not appropriate for you to prepare records based on information that you did not personally observe. Information gathering via an interview with the boat captain after arrival at the dock is not an acceptable substitute for records by fishermen based on their own observations.

Let's look at an example of a harvest vessel record inappropriately prepared by a processor. Here's an example of an actual record used by a primary processor. The record form initially appears to be set up to include some of the key information we've talked about, such as method of capture, time of death, sea and air temperatures, and method of cooling. But, the record is filled out by the processor, not the fishermen, and offers little to no assurance that the fish received were handled onboard in a manner that prevents the formation of scombrotoxin.

Here are some of the problems. The record gathers information about multiple vessels based on date of receipt by the primary processor rather than information recorded by an individual vessel. Although the

record includes a line for time of death, the information actually recorded is not meaningful. Instead, when the boat arrives, the processor records such things as the number of sets or number of days fished by each vessel. And while the record states generically that the method of cooling is by chill tank, there is no documentation of what cooling media is actually used or when cooling of the fish begins.

The recorded sea and air temperatures in this record are also useless. It turned out that the processor only recorded the air temperature at the dock on the day of receipt, which provides no information related to the exposure of the fish during harvest or onboard the vessel during the multi-day fishing trips. And, while the record states that fish are held in an ice hold on each vessel, the record provides no information related to the actual exposure conditions or maintenance of the ice around the fish in the hold during the fishing trip. Instead, the processor recorded average temperatures of the fish during off-loading in this part of the record.

This record, and records like it, does not provide assurance that the fishermen took steps necessary to prevent scombrotoxin formation or that the fish received from the vessels should be considered safe. The records should not have been found acceptable by the firm's responsible management or regulators.

Nevertheless, there are rare scenarios where you can monitor and record sufficient information about the fishing operation to generate a processor-recorded harvest vessel record that demonstrates the fish received are safe. The key is whether the information needed can be observed and collected by you first-hand. Let's look at an example.

In this example, the processor receives fish from a small, independent fleet of day-boat hook-and-line fishermen. The fishermen start out early in the morning by taking on ice at the processing facility and then fish in nearby waters. The fish are landed alive, killed onboard, and iced whole. The fishermen are generally back within six or seven hours, mid-day, to off-load. The short duration of the trip allows the processor to record sufficient, meaningful, first-hand observations.

The processor keeps a daily log of the vessels as they are iced up and set out for a day of fishing. Later, the processor logs the time the fishermen return and whether there is sufficient ice surrounding the fish. The processor also looks up the day's high air and water temperatures for the areas fished by using the National Oceanic and Atmospheric Administration's online buoy database. Because the fish die on the vessel, the air temperature is the more critical factor, and using the temperature for mid-day when the fish are delivered reliably reflects the worst case exposure in most circumstances. Provided the temperatures remain below 83 degrees Fahrenheit and the vessels return within the typical 6 to 7 hours, the processor's observations can ensure the receipt of fish within FDA's recommended safe chilling time of nine hours for whole fish. If temperatures start to approach 83 degrees, the processor contacts the fishermen to return within 6 hours from the time of departure or to keep separate onboard records of their own observations that ensure the fish were chilled within 6 hours.

A final word of caution - some near-shore day-boat fishing operations may be able to limit their time fishing to meet FDA's recommended safe time-to-chill recommendations to prevent scombrotoxin formation without ever actually chilling the fish onboard. However, this practice could result in the fish becoming decomposed or susceptible to pathogens, which could adulterate the fish, which is a prohibited act under U.S. law. Unless they are kept alive until delivered to you, the fish should be chilled on the harvest vessel soon after capture.

In conclusion, the discussion and the examples just presented should help you develop and use meaningful harvest vessel records as part of an effective HACCP program to prevent scombrotoxin formation. Remember, harvest vessel records are just one part of this control strategy. You should also conduct other control measures discussed in the companion video, including internal temperature monitoring and sensory examinations of the fish at the receiving critical control point, in addition to the development and implementation of appropriate corrective actions and verification procedures.

Also, though the harvest vessel record examples reviewed in this video should be adequate under the conditions described, you should tailor your records to fit your specific operations. It may not be enough to simply copy the examples presented here or to copy someone else's record forms. It's in your business' best interest to make sure that your HACCP program does everything needed to prevent scombrotoxin formation and to protect consumers of your fish from scombrotoxin poisoning.