

Appendix III: **Hazards Found in Seafood**

Appendix 3 - Hazards Found in Seafood

Notes:

Overhead 1

Objective:

In this module, you will learn:

- The identity and characteristics of biological, chemical and physical safety hazards commonly identified with seafood.
- Control measures for hazards in seafood.

Biological Hazards

Biological safety hazards commonly found in seafood include bacterial pathogens, viral pathogens and parasites.

- **Bacterial Pathogens**

Pathogen contamination and growth is often an important factor in food-borne illness.

Overhead 2

Bacterial Pathogens:

- *Bacillus cereus*
- *Campylobacter jejuni*
- *Clostridium botulinum*
- *Clostridium perfringens*
- Pathogenic *Escherichia coli*
- *Listeria monocytogenes*
- *Salmonella spp.*
- *Shigella spp.*
- Pathogenic *Staphylococcus aureus*
- *Vibrio cholerae*
- *Vibrio parahaemolyticus*
- *Vibrio vulnificus*
- *Yersinia enterocolitica*

Bacillus cereus

Food poisoning caused by *B. cereus* may occur when foods are prepared and held without proper refrigeration for several hours before being served. *B. cereus* is an aerobic spore-forming bacterium. It is commonly found in soil, on vegetables, and in many raw and processed foods. Consumption of foods that contain $10^6/g$ may result in food poisoning. Foods incriminated in food poisoning outbreaks include cooked meat and vegetables, boiled or fried rice, vanilla sauce, custards, soups, and raw vegetable sprouts. Two types of illnesses have been attributed to *B. cereus*. The first is characterized by abdominal pain and diarrhea. It has an incubation period of 4-16 hours and symptoms that last for 12-24 hours. The second is characterized by an acute attack of nausea and vomiting. It has an incubation period of 1-5 hours. Diarrhea is not common with the second type of illness.

B. cereus is a common food contaminant. Effective control measures depend on destruction by a heat process and temperature control to prevent spore germination and multiplication of vegetative cells in cooked, ready-to-eat foods. Measures to reduce or eliminate the threat of food poisoning by *B. cereus* include: 1) Avoid preparing food too far in advance of planned service, 2) Avoid holding cooked foods at room temperature, 3) Use quick chill methods to cool foods below 45°F (7.2°C) within 4 hours of preparation; store in shallow pans/ small quantities with the food less than 4 inches deep; if food is especially thick (e.g., refried beans), store no more than 3 inches deep, 4) Hold/store hot foods above 140°F (60°C) until served, and 5) Reheat foods rapidly to 165°F (74°C) or above.

Campylobacter jejuni

C. jejuni is widely distributed in the intestinal tract of poultry, livestock, and warm-blooded domestic animals. It is a very common and important cause of diarrheal illness in humans. Symptoms include profuse diarrhea (sometimes bloody), abdominal pain (intensity and duration can be somewhat severe), headache, weakness, and fever. Many infections occur without symptoms. *C. jejuni* is transmitted through: contaminated foods, including raw clams, mussels and oysters; person-to-person contact; and contaminated water. Cross-contamination of foods by dirty food-contact surfaces, including cutting boards and hands, may be the most frequent route of transmission.

Hazards from *C. jejuni* can be controlled by thoroughly cooking seafood and by stressing the importance of proper (and frequent) hand and equipment washing and sanitary food-handling practices. Since the infective dose of *C. jejuni* is thought to be small, time/temperature abuse of food products is not necessary to result in this illness.

Clostridium botulinum

C. botulinum is found throughout the environment and has been isolated from soil, water, vegetables, meats, dairy products, ocean sediments, the intestinal tracts of fish, and the gills and viscera of crabs and other shellfish. *C. botulinum* is a spore-forming bacteria that grows in the absence of air. These characteristics allow it to survive normal cooking temperatures and to grow in a vacuum-packaged and modified-atmosphere environment. *C. botulinum* produces a powerful neurotoxin that causes botulism. Growth is necessary for *C. botulinum* to produce toxin. Symptoms include diarrhea, vomiting, abdominal pain, nausea and weakness. These are followed by double, blurred vision and dilated, fixed pupils. In severe cases, paralysis of the muscles responsible for breathing can cause death.

The type of *C. botulinum* Type E that is most common in fish and fishery products is of particular concern because it grows at temperatures as low as 38 F and produces little noticeable evidence of spoilage. *C. botulinum* Type A is the form of this bacteria that is most common in land-based products. It is a common contaminant on processing equipment. It will grow at tempera-

Continued

Notes:

Appendix 3 - Hazards Found in Seafood

Notes:

tures no colder than 50 F and produces a putrid odor in products in which it grows. However, its spores are much more heat-resistant than the Type E form of the bacteria.

Because *C. botulinum* produces heat-resistant spores and requires the absence of oxygen for growth, botulism has been most commonly associated with improperly canned food (usually home canned). Semi-preserved seafood, including smoked, salted and fermented fish, have also been identified as causes of botulism.

Hazards from *C. botulinum* can be controlled by inhibiting growth of the bacteria or by destroying it in seafood. Proper thermal processes for canned seafood destroy the bacteria. Heavy salting or drying to reduce the water activity below 0.93 and fermentation or acidification to below pH 4.6 are effective means of preventing *C. botulinum* growth. Maintaining proper storage temperatures alone is not considered an adequate control measure for *C. botulinum* Type E because of its ability to grow at low temperatures and because of the severity of the illness. Nonetheless, in many products, it is an important second barrier to growth.

Clostridium perfringens

C. perfringens is commonly found in soil, dust, and the intestinal tract of animals. It is a spore forming, anaerobic (oxygen-free growth conditions) bacterium. Food poisoning caused by *C. perfringens* may occur when foods such as meat or poultry are cooked and held without maintaining adequate heat or refrigeration before serving. The illness is a self-limiting gastroenteritis with an incubation period of 8-15 hours and a duration of 12-24 hours. The symptoms, which include intense abdominal cramps, gas, and diarrhea, have been attributed to a protein enterotoxin produced during sporulation of the organism in the intestine.

The presence of small numbers of *C. perfringens* is not uncommon in raw meats, poultry, dehydrated soups and sauces, raw vegetables, and spices. Because the spores of some strains are resistant to temperatures as high as 100°C for more than 1 hour, their presence in foods may be unavoidable. Furthermore, the oxygen level may be sufficiently reduced during cooking to permit growth of the clostridia. Spores that survive cooking may germinate and grow rapidly in foods that are inadequately refrigerated after cooking. Thus, when clinical and epidemiological evidence suggests that *C. perfringens* is the cause of a food poisoning outbreak, the presence of hundreds of thousands or more of these organisms per gram of food substantiates the diagnosis.

Control measures emphasize proper food preparation and storage techniques, especially temperature control. Control measures include:

- 1) Rapid, uniform cooling of cooked foods to <10°C (50°F) within 2-3 hours;
- 2) Hot holding of cooked foods at or above 60°C (140°F);
- 3) Reheating cooled or chilled foods to a minimum internal temperature of 75°C (167°F) immediately before serving;

- 4) Not leaving foods at room temperature or thawing frozen foods at room temperature;
- 5) Preventing cross-contamination of cooked foods with bacteria from raw foods by using separate food-contact surfaces for preparing raw and cooked foods items, or by thoroughly cleaning and sanitizing food-contact surfaces after being used for raw products;
- 6) Maintaining food preparation areas so that they are free of soil and dust;
- 7) Cleaning and sanitizing meat slicers, meat-cutting equipment, food contact surfaces, and other equipment after use; and
- 8) Using good personal hygiene methods, and thoroughly washing hands frequently when handling food products, especially after handling raw products and before handling cooked products.

Notes:

Escherichia coli

E. coli are naturally found in the intestinal tracts of all animals, including humans. Most forms of the bacteria are not pathogenic and serve useful functions in the intestine. Pathogenic strains of *E. coli* are transferred to seafood through sewage pollution of the coastal environment or by contamination after harvest. *E. coli* food infection causes abdominal cramping, water or bloody diarrhea, fever, nausea, and vomiting.

Hazards from *E. coli* can be prevented by: heating seafood sufficiently to kill the bacteria, holding chilled seafoods below 40 F, preventing post-cooking cross-contamination, and prohibiting people who are ill from working in food operations. The infective dose of *E. coli* is dependent upon the particular strain from only a few organisms to millions. For this reason, time/temperature abuse of food products may or may not be necessary to result in illness.

Listeria monocytogenes

L. monocytogenes is widespread in nature and has been isolated from soil, vegetation, marine sediments and water. In the early 1900s, *L. monocytogenes* was recognized as a bacterium that caused illness in farm animals. More recently, it has been identified as the cause of listeriosis in humans. Most healthy individuals are either unaffected by *L. monocytogenes* or experience only mild flulike symptoms. Victims of severe listeriosis are usually immunocompromised. Those at highest risk include: cancer patients, individuals taking drugs that affect the body's immune system, alcoholics, pregnant women, persons with low stomach acidity and individuals with AIDS. Severe listeriosis can cause meningitis, abortions, septicemia and a number of other maladies, some of which may lead to death.

The greatest threat of listeriosis is from ready-to-eat products that do not require further cooking at home. *L. monocytogenes* in raw food that will be cooked before consumption is less of a concern to the food industry since the bacteria are killed during cooking. *L. monocytogenes* has been

Continued

Appendix 3 - Hazards Found in Seafood

Notes:

isolated from raw fish, cooked crabs, raw and cooked shrimp, raw lobster, surimi and smoked fish. One of its most significant characteristics is its ability to grow at temperatures as low as 31°F.

Hazards from *L. monocytogenes* can be prevented by thoroughly cooking seafood and by preventing cross-contamination once the seafood is cooked. Since the infective dose of *L. monocytogenes* is thought to be small, time/temperature abuse of food products may not be necessary to result in illness.

Salmonella spp.

Salmonella is naturally found in the intestinal tracts of mammals, birds, amphibians and reptiles but not in fish, crustaceans or mollusks. *Salmonella* is transferred to seafood through sewage pollution of the harvest environment or by contamination after harvest.

Salmonella food infection causes nausea, vomiting, abdominal cramps and fever. Outbreaks of *Salmonella* food infection have been associated with raw oysters, salmon, tuna salad, shrimp cocktail, stuffed sole and gefilte fish.

Hazards from *Salmonella* can be prevented by: heating seafood sufficiently to kill the bacteria, holding chilled seafood below 40 F, preventing post-cooking cross-contamination and prohibiting people who are ill or are carriers of *Salmonella* from working in food operations. The infective dose of *Salmonella* is thought to be extremely variable, relatively high for healthy individuals and very low for at-risk individuals, such as the elderly or medically compromised. For this reason, illness could result even without time/temperature abuse, but abuse has been a contributing factor in many outbreaks.

Shigella spp.

Shigella is naturally found in the intestinal tract of humans. *Shigella* is transferred to seafood through sewage pollution of the coastal environment or by contamination after harvest. *Shigella* produces an illness called Shigellosis, which causes mild diarrhea, fever, abdominal cramps and severe fluid loss.

Hazards from *Shigella* can be prevented by eliminating human waste contamination of water supplies and by improved personal hygiene for people who are ill or are carriers of *Shigella* and work in food operations.

Staphylococcus aureus

Humans and animals are the primary reservoirs for *S. aureus*. *S. aureus* can be found in the nose and throat and on the hair and skin of 50 percent of healthy individuals. However, the bacteria can be found in air, dust, sewage and surfaces of food-processing equipment. *S. aureus* can produce a toxin if allowed to grow in food. The toxin is not destroyed by the cooking or canning processes. *S. aureus* has the ability to grow and

produce toxins in food with very little available water (.85 a_w , 10 percent salt), which would prevent the growth of other pathogens.

S. aureus food poisoning causes nausea, vomiting, abdominal cramping, watery or bloody diarrhea, and fever.

Hazards from *S. aureus* can be prevented by: minimizing time/temperature abuse of seafood, especially after cooking, and requiring that food handlers engage in proper hygiene.

Vibrio cholerae

V. cholerae is found in estuaries, bays, and brackish waters. It is naturally occurring and is not necessarily related to sewage contamination.

V. cholerae tends to be more numerous in the environment during warmer months.

There are a number of types of *V. cholerae*, and these produce very different symptoms. One type, *Vibrio cholerae* 01, initially causes abdominal discomfort and mild diarrhea. As the illness progresses, the symptoms may include: watery diarrhea, abdominal cramps, vomiting and dehydration. Death can occur. Susceptibility to cholera is enhanced in people who have had gastric surgery, take antacids or have type O blood. Outbreaks of this type of cholera have been associated with oysters, crabs and shrimp from the Gulf of Mexico. *V. cholerae* 01 has also been recovered from Chesapeake Bay waters, although no illness has been reported from that area.

Another type of *V. cholerae*, non-01, causes diarrhea, abdominal cramps and fever. Nausea, vomiting and bloody diarrhea have also been reported. The severity of the symptoms is dependant, in part, upon the specific strain. In its most severe form, *V. cholerae* non-01 has resulted in septicemia (blood poisoning) in individuals with medical conditions that weaken their immune systems. The illness has been associated with consumption of raw oysters, but the bacterium has also been found in crabs.

Hazards from *V. cholerae* can be prevented by cooking seafood thoroughly and by preventing cross-contamination once the seafood is cooked.

Vibrio parahaemolyticus

V. parahaemolyticus is naturally occurring in estuaries and other coastal areas throughout most of the world. In most areas, *V. parahaemolyticus* is more numerous in the environment during the warmer months and, as a result, most outbreaks in the United States occur during the summer.

The most commonly experienced symptoms of *V. parahaemolyticus* illness include: diarrhea, abdominal cramps, nausea, vomiting and headache. Fever and chills are less frequently reported. The illness has been associated with consuming contaminated crabs, oysters, shrimp and lobster.

Notes:

Continued

Appendix 3 - Hazards Found in Seafood

Notes:

Hazards from *V. parahaemolyticus* can be controlled by thoroughly cooking seafood and preventing cross-contamination after cooking. Control of time/temperature abuse is also an important preventative measure.

Vibrio vulnificus

V. vulnificus is a naturally occurring marine bacterium. *Vibrio vulnificus* requires salt for survival and is commonly isolated at salinities of 7 ppt to 16 ppt. It is primarily found in the Gulf of Mexico, but it has also been isolated from the Atlantic and Pacific oceans. The numbers of the bacterium in the environment are highest during the warmer months of April through October.

The most common symptoms include: skin lesions, septic shock, fever, chills and nausea. Abdominal pain, vomiting and diarrhea are less frequently reported. Death occurs in about 50 percent of the cases. A number of medical conditions make individuals more susceptible to the life-threatening effects of this bacterium, including: liver disease, alcohol abuse, cancer, diabetes, chronic kidney disease, immunosuppressive drug or steroid usage, low stomach acidity and AIDS. *V. vulnificus* sepsis has been associated with the consumption of certain molluscan shellstock.

Hazards from *V. vulnificus* can be controlled by thorough cooking of shellfish and by preventing cross-contamination once the seafood is cooked. The risk of *V. vulnificus* infection may also be reduced by rapidly refrigerating oysters from the Gulf Coast during warm-weather months. Individuals in the “high risk” groups should not consume raw molluscan shellfish.

Yersinia enterocolitica

Y. enterocolitica is naturally found in soil, water and domesticated and wild animals. Yersiniosis causes diarrhea, vomiting, abdominal pain and fever, often mimicking appendicitis. Outbreaks have been associated with oysters and fish.

Hazards from *Y. enterocolitica* can be prevented by: heating seafood sufficiently to kill the bacteria, holding chilled seafoods below 40 F and preventing post-cooking cross-contamination.

• *Viral Pathogens*

Overhead 3

Viral Pathogens:

- Hepatitis A Virus
- Norwalk Virus

Hepatitis A Virus

Viruses survive better at low temperatures and are killed at high temperatures. As a result, most outbreaks of hepatitis occur during winter and early spring. Viruses can remain alive for long periods of time in seawater and have been shown to survive over one year in marine sediments.

Both raw and steamed clams, oysters, and mussels have been implicated in outbreaks of hepatitis A. Symptoms of hepatitis A include weakness, fever and abdominal pain. As the illness progresses, the individual usually becomes jaundiced. The severity of the illness ranges from very mild (young children often experience no symptoms) to severe, requiring hospitalization. The fatality rate is low, and deaths primarily occur among the elderly and individuals with underlying diseases.

Hazards from hepatitis A can be prevented by thoroughly cooking seafood and by preventing cross-contamination of cooked seafood. But hepatitis A appears to be more resistant to heat than other viruses. A laboratory study showed that hepatitis A viruses in infected oysters were inactivated after heating at 140 F for 19 minutes. Therefore, mollusks steamed only until the shells open (a common cooking practice) are not exposed to heat long enough to inactivate hepatitis A viruses.

Norwalk Virus

Norwalk virus is considered a major cause of nonbacterial intestinal illness (gastroenteritis). Illness from Norwalk virus has been associated with eating clams (raw and steamed), oysters and cockles. Norwalk virus causes nausea, vomiting, diarrhea, abdominal cramps, and occasionally fever in humans.

Hazards from Norwalk virus can be prevented by thoroughly cooking seafood and by preventing cross-contamination of cooked seafood. Additionally, a recent outbreak has demonstrated that controlling overboard discharge of untreated sewage from shellfish harvesting vessels would reduce the incidence of illness attributable to Norwalk virus.

• *Parasites*

Overhead 4

Parasites:

- *Anisakis simplex*
- *Pseudoterranova decipiens*
- *Diphyllobothrium latum*

Notes:

Continued

Appendix 3 - Hazards Found in Seafood

Notes:

Anisakis simplex

Anisakis simplex, commonly called herring worm, is a parasitic nematode or roundworm. Its final hosts are dolphins, porpoises and sperm whales. The larval (wormlike) stage in fish and squid is usually 18 to 36 millimeters in length, 0.24 to 0.69 millimeters in width and pinkish to whitish in color.

Anisakiasis, the human illness caused by *Anisakis simplex*, is associated with eating raw fish (sushi, sashimi, lomi lomi, ceviche, sunomono, Dutch green herring, marinated fish and cold-smoked fish) or undercooked fish.

Parasites in fish are considered a hazard only in fish that the processor knows or has reason to believe will be served raw or undercooked. In other products, parasites are considered filth but not hazardous. The FDA has established three freezing processes to kill parasites. Freezing and storing at -4°F (-20°C) or below for 7 days (total time), or freezing at -31°F (-35°C) or below for 15 hours, or freezing at -31°F (-35°C) or below until solid and storing at -4°F (-20°C) or below for 24 hours is sufficient to kill parasites. FDA's Food Code recommends these freezing conditions to retailers who provide fish intended for raw consumption. Note: these conditions may not be suitable for freezing particularly large fish (e.g. thicker than six inches).

Pseudoterranova decipiens

Pseudoterranova decipiens, commonly called “codworm” or “sealworm,” is another parasitic nematode or roundworm. The usual final hosts of *Pseudoterranova* are gray seals, harbor seals, sea lions and walruses. The larval stage in fish are 5 to 58 millimeters in length, 0.3 to 1.2 millimeters in width and yellowish, brownish or reddish in color.

These nematodes are related to *Anisakis simplex* and the disease associated with infections is also termed anisakiasis. These nematodes are also transmitted to humans through raw or undercooked fish. Control of *Pseudoterranova* is the same as for *Anisakis simplex*.

Diphyllobothrium latum

Diphyllobothrium latum is a cestode, or tapeworm, that parasitizes a variety of fish-eating mammals of the northern latitudes. A similar species is found in the southern latitudes and is associated with seal hosts. Cestodes have a structure that allows them to attach to the intestinal wall of their host and have segmented bodies. Cestode larvae found in fish range from a few millimeters to several centimeters in length and are white or gray in color.

Diphyllobothrium tapeworms primarily infect freshwater fish. But salmon and related fish can also carry the parasites. *Diphyllobothrium* tapeworms are usually found unencysted and coiled in musculature or encysted in viscera. These tapeworms can mature and cause disease in humans. These

cestodes are also transmitted to humans through raw or undercooked fish. Control of *Diphyllobothrium* is the same as for *Anisakis simplex*.

Chemical Hazards

• Marine Biotoxins

Marine biotoxins (natural toxins) represent a significant threat to human health when humans consume fish and fishery products contaminated with them. The marine biotoxins comprise many distinct compounds, all produced by species of naturally occurring marine algae. The algae are at the bottom of the marine food chain. Consequently, the biotoxins produced by some algae are collected and concentrated through levels of the food chain (e.g., mollusks, crustaceans and finfish) and ultimately are consumed by humans.

There are several recognized marine biotoxins in the United States; e.g. paralytic, neurotoxin, diarrhetic, and amnesic shellfish poisonings and ciguatera fish poisoning. Molluscan shellfish waters are classified by state shellfish-control agencies to reduce the risk that these toxins will be carried by shellfish in commercial channels. Processors should obtain molluscan shellfish only from those waters that have been approved for harvest.

Overhead 5

Marine Toxins:

- Amnesic Shellfish Poisoning (ASP)
- Diarrhetic Shellfish Poisoning (DSP)
- Neurotoxic Shellfish Poisoning (NSP)
- Paralytic Shellfish Poisoning (PSP)
- Ciguatera Fish Poisoning (CFP)
- Gempylotoxin
- Scombroid Toxin
- Tetrodotoxin

FDA has established action levels for all of the marine biotoxins except CFP. None of these toxins can be fully destroyed by normal cooking, freezing, salting, acidification or smoking processes. However, there is some evidence that PSP levels, and perhaps levels of other shellfish toxins, can be reduced to safe levels through commercial canning processes.

Notes:

Continued

Appendix 3 - Hazards Found in Seafood

Notes:

Amnesic Shellfish Poisoning (ASP)

ASP has been caused by contaminated molluscan shellfish, primarily from cold water regions of North America. The shellfish become contaminated with domoic acid produced by dense growths of an algae in the genus *Pseudonitzschia*. It should be assumed that all filter-feeding mollusks are capable of accumulating domoic acid. However, the only shellfish implicated in cases of ASP have been mussels. ASP has recently been identified as a problem in the viscera of dungeness, tanner, and red rock crabs, and anchovies along the U.S. West Coast.

In the early stages of ASP, the individual usually experiences intestinal distress. Severe ASP can cause a facial grimace or chewing motion, short-term memory loss and difficulty breathing. Death can occur.

Diarrhetic Shellfish Poisoning (DSP)

DSP is caused by contaminated molluscan shellfish. There has been no documented occurrence to date in the United States. However, instances have been documented in Japan, Southeast Asia, Scandinavia, western Europe, Chile, New Zealand, and eastern Canada. Filter-feeding mollusks can accumulate toxins even at algae concentrations below that necessary to discolor the water. Mussels, oysters, hard clams and soft-shell clams have been implicated in cases of DSP. Contaminated scallops have caused cases of DSP in Japan, but the likelihood of scallops causing illness in this country is reduced because roe-on scallops are not typically consumed in the United States. A number of algae species in the genus *Dinophysis* and *Prorocentrum* have been associated with DSP. These algae are responsible for the production of a number of toxins (okadaic acid and its derivatives).

The symptoms of diarrhetic shellfish poisoning are diarrhea, nausea, vomiting, moderate to severe abdominal pain and cramps, and chills. No known fatalities have occurred, and total recovery is expected within three days with or without medical assistance.

Neurotoxic Shellfish Poisoning (NSP)

Gymnodinium breve was first recognized as causing NSP in the mid 1960s. Blooms of this algae usually result in fish kills and can make shellfish toxic to humans. The blooms generally begin offshore and move inshore. *G. breve* produces three known toxins (brevetoxins).

NSP is caused by contaminated shellfish from the southeastern United States and New Zealand. Oysters and clams are the only shellfish associated with NSP illness. However, all filter-feeding mollusks are capable of accumulating neurotoxic shellfish toxins.

NSP resembles a mild case of ciguatera or PSP. Symptoms begin within three hours of consuming contaminated shellfish and include: tingling of the face that spreads to other parts of the body, cold-to-hot sensation reversal, dilation of the pupils and a feeling of inebriation. Less commonly, victims may experience: prolonged diarrhea, nausea, poor coordination and burning pain of the rectum.

Paralytic Shellfish Poisoning (PSP)

There are many species of toxic algae that cause paralytic shellfish poisoning. These include algae in the genus *Alexandrium*, *Pyrodinium* and *Gymnodinium*. PSP can be caused by a combination of any of 18 toxins (saxitoxins), depending on the species of algae, geographic area and type of shellfish involved.

PSP is caused by contaminated shellfish primarily from the U.S. Northeast and Northwest and imports from similar climates. All filter-feeding mollusks accumulate paralytic shellfish toxins. Mussels become highly toxic within a few hours to a few days exposure to the organism but also lose their toxin load rapidly. Clams and oysters generally do not become as toxic as mussels. They require more time to accumulate high levels of toxins and also require longer to cleanse themselves. Scallops can become extremely toxic, even during periods when blooms are not evident. However, scallops generally do not pose a PSP threat because the adductor muscle, the only part of the scallop traditionally consumed in Western society, does not accumulate toxin. PSP has recently been reported in the liver of Atlantic mackerel, American lobsters, and cold-water crabs such as dungeness, tanner, and red rock crab.

Symptoms of PSP initially involve numbness and a burning or tingling sensation of the lips and tongue that spreads to the face and fingertips. This leads to general lack of muscle coordination in the arms, legs and neck. A variety of other less commonly reported symptoms also exist. Severe cases of PSP have resulted in respiratory paralysis and death.

Ciguatera Fish Poisoning (CFP)

By eating toxic algae, certain species of tropical and subtropical fish can become toxic to humans. The algae species most often associated with CFP is *Gambierdiscus toxicus*, but others are occasionally involved. Toxic algae populations tend to fluctuate, influenced by the turbidity and nutrient content of the water. There are at least four known toxins that concentrate in the viscera, head or central nervous system of affected fish. Ciguatoxin is the principal toxin.

CFP is carried to humans by contaminated finfish from the extreme southeastern United States, Hawaii, the tropics, and subtropics worldwide (between 35N and 34S latitude). In South Florida, Bahamian and Caribbean regions, barracuda, amberjack, horsey jack, black jack, other large species of jack, king mackerel, large groupers and snappers are likely to contain ciguatoxin. Many other species of large fish-eating fish may be suspect. In Hawaii and throughout the central Pacific, barracuda, amberjack and snapper are frequently ciguatoxic, and many other species, both large and small, may be suspect. Mackerel and barracuda from mid to northeastern Australian waters are frequently ciguatoxic.

Notes:

Continued

Appendix 3 - Hazards Found in Seafood

Notes:

The incidence of poisonous fish is sporadic. Not all fish of the same species and caught in the same area will necessarily be toxic. A study done in Hawaii indicated that if fish in one location are toxic, other fish in the vicinity are 60 percent likely to be toxic. Both plant-eating and fish-eating fish can become toxic. Plant-eating fish become toxic by eating the toxic algae itself. Fish-eating fish become toxic by consuming toxic plant-eating fish. Large fish are more likely to be poisonous than small fish because they consume greater amounts of the toxins.

Ciguatera causes: diarrhea, abdominal pain, nausea, vomiting, abnormal or impaired skin sensations, vertigo, lack of muscle coordination, cold-to-hot sensation reversal, muscular pain and itching. Some of the symptoms may recur for as long as six months. Death occasionally results.

Currently, the principal test method is a mouse bioassay that is not suitable for commercial use. There is no validated method suitable for shipboard or dockside testing of large catches of fish. However, some such tests are being evaluated and may soon be available. In the meantime, for those in the fish industry to avoid ciguatoxic fish, they must rely on local knowledge of safe harvest areas and avoid harvest from any officially designated areas or species.

• *Other Marine Toxins*

Gempylotoxin

The gempylids, escolar or pelagic mackerels are a small group of fish-eating oceanic fish. Important species in this group include: *Lepidocybium flavobrunneum* (escolar — California, Peru, Hawaiian Islands, Australia, South Africa, Cuba, Aru Islands, Madeira), *Ruvettus pretiosus* (oilfish, castor oil fish, purgative fish — tropical Atlantic and Indo-Pacific oceans).

Gempylids produce an oil that has a purgative effect. The diarrhea caused by eating the oil contained in the flesh and bones of gempylid fish develops rapidly and is pronounced but generally without pain or cramping. No other bad effects have been reported. There are not specific legal restrictions, but authorities advise caution that gempylid fish, including escolar, should not be imported or marketed in the United States.

Scombroid Toxin (Histamine)

Scombroid poisoning, also known as histamine poisoning, is caused by eating fish of certain species that have undergone spoilage by types of bacteria. These bacteria produce an enzyme that reacts with natural components of the fish flesh to produce histamine. Fish that have been involved in scombroid poisonings include tuna, mahi mahi, bluefish, sardines, amberjack and mackerel. The toxin is not eliminated by cooking or canning.

Scombroid toxicity is a common illness associated with certain seafood. Illnesses are commonly reported each year. Deaths are rarely reported.

Symptoms of scombroid poisoning begin within four hours of eating contaminated fish. The most common symptoms include: a metallic, sharp or peppery taste; nausea; vomiting; abdominal cramps; diarrhea; swelling and flushing of the face; headache; dizziness; heart palpitations; hives; rapid and weak pulse; thirst; and difficulty in swallowing.

The histamine-forming bacteria usually grow rapidly only at high temperatures. At 90 F (32.2 C), unsafe levels of histamine may appear within six hours; at 70 F (21 C), 24 hours. Because wide variations occur between individual fish even under the same conditions, it is necessary to consistently remove heat rapidly from the freshly harvested fish and maintain a low temperature until the fish are prepared for consumer use. Particularly for large fish, special precautions and equipment are required for the rapid removal of heat. Periodic increases in product temperature during storage can result in more histamine being formed. Histamine may form without the usual odors of decomposition. Sensory analysis is an effective screening method that reduces the risk of accepting histamine-containing fish. Chemical analysis for histamine is also possible. A detailed knowledge of the temperature history of the product provides the best control measure.

Tetrodotoxin (puffer fish)

Puffer fish, also called fugu or blowfish, contain the potent toxin, tetrodotoxin. It is unclear whether the fish itself produces the toxin, or like ciguatera, it is introduced to the fish by eating toxic algae. There are approximately 80 species of puffer fish that are known to contain tetrodotoxin in the Pacific, Atlantic and Indian oceans. The domestic species of puffer, sometimes called sea squab, is much less poisonous than the Japanese species.

Symptoms of poisoning usually begin within 10 minutes of consuming puffer fish. The victim first experiences numbness and tingling of the mouth. This is followed by weakness, paralysis, decreased blood pressure, and quickened and weakened pulse. Death can occur within 30 minutes. Puffer fish may not be imported into the United States except under strict certification requirements and specific authorization from FDA.

Notes:

Continued

Notes:

Other Chemical Hazards

Overhead 6

Other Chemical and Physical Hazards:

- Aquaculture Drugs
- Allergens
- Chemical Contaminants
- Food Additives
- Glass
- Metal Fragments

• *Aquaculture Drugs*

Animal drugs may be used in the raising of aquatic species: 1) to treat or prevent disease, 2) to control parasites, 3) to affect reproduction, and 4) to tranquilize. Illegal residues of drugs may occur in aquaculture species because of the use of unapproved drugs, use of drugs not in accordance with the approved labeling directions, failure to follow approved withdrawal times, or use of general purpose chemicals not labeled or approved for drug use. There are only a few approved drugs for aquatic species. However, FDA approval is required before any animal drug is used to ensure that unsafe drug residues will not occur in edible tissue when animals are treated following approved label directions. The withdrawal period is the period from the last time of drug treatment until the residuals are allowed to reduce or be eliminated in the edible portions. The withdrawal time is usually within a number of days, depending on the drug, dosage, and growth of the seafood. Producer quality-assurance programs provide information and guidance for proper use of approved compounds and record-keeping practices that can be referenced in processor HACCP plans. Processors may consider conducting on-site audits of the animal-drug controls used by their producers. If rapid screening tests are considered for use by the processor or producer to detect or monitor drug residues in aquatic species, they must be validated for their intended use. These tests should only be used as a part of a complete risk-reduction, quality-assurance program and not be used as the only monitoring tool. Presently, FDA has no data to indicate these tests will provide reliable, quantitative results for drug screening in farm-raised aquatic species.

• *Allergens*

Certain food and color additives can cause an allergic-type reaction (food intolerance) in consumers. Examples of such food and color additives that are used on fish and fishery products include: sulfiting agents and FD&C Yellow #5. Sulfiting agents are mostly used during on-board handling of shrimp and lobster to prevent the formation of "black spot." They are sometimes used by cooked octopus processors as an antioxidant, to retain the red color of the octopus skin. FD&C Yellow #5 is used during in-plant

processing. These food and color additives are permitted for use in foods—with certain restrictions—but their presence must be declared on the label. This label declaration is particularly important to sensitive individuals.

Certain other food and color additives are prohibited from use in food because of a determination by FDA that they present a potential risk to the public health. Examples of such food and color additives include: safrole and FD&C Red #4.

Additionally, a number of foods contain allergenic proteins that can pose a health risk to certain sensitive individuals. Foods that account for most of all food allergies include peanuts, soybeans, milk, eggs, fish, crustaceans, tree nuts and wheat. If these foods are part of, or are directly added to your fishery product, you must ensure that the product is properly labeled. However, these controls are not designed to prevent the unintentional introduction of allergenic proteins from such foods into your fishery product because of cross-contact (e.g. use of common equipment, improper production scheduling, or improper use of rework material). Unintentional introduction of allergenic proteins must be controlled through a rigorous sanitation regime, either as part of a prerequisite program or as part of HACCP itself.

• *Chemical Contaminants*

Fish are harvested from waters that are exposed to varying amounts of environmental contaminants. Industrial chemicals, pesticides, and many toxic elements may accumulate in fish at levels that can cause public health problems. Of greatest concern are fish harvested from freshwater, estuaries, and nearshore waters rather than from the open ocean. Pesticides and herbicides used near aquaculture operations are also of concern. Federal tolerances or action levels are established for some of the most toxic and persistent contaminants. States often use limits for deciding whether to close waters for harvesting. Processors should be aware of these closures and should not purchase fish that have been harvested in closed areas. Pesticides and herbicides that may be used near aquaculture operations are also potential problems. Producer quality-assurance programs provide useful information for avoiding potential contaminants from a variety of sources, beginning with proper site selection.

• *Food Additives*

Food and color additives are used in many fish and fishery products, including some usage by fishermen and aquaculturists. Many additives are acceptable in such products when used in conformity with GMPs and established limits. Other additives are not permitted in fish or fishery products. Before using a food additive, the processor should become familiar with the applicable legal limitations for its use. The processor should be especially aware of food additives that are known to cause allergic-type reactions or are otherwise linked to adverse health conse-

Notes:

Appendix 3 - Hazards Found in Seafood

Notes:

quences if not properly used. These reactions can be severe (e.g., anaphylactic shock induced by sulfites or yellow 5 and 6 can be fatal). The use of color additives that are permitted should be carefully controlled to ensure they remain within established limits. Correct listing of food and color additives on the product label is a legal requirement.

• *Glass*

Glass fragments can cause injury to the consumer. FDA's Health Hazard Evaluation Board has supported regulatory action against products with glass fragments of 0.3" (7 mm) to 1.0" (25 mm) in length. See FDA Compliance Policy Guide #555.425.

Glass inclusion can occur whenever processing involves the use of glass containers. Normal handling and packaging methods, especially mechanized methods, can result in breakage. Most products packed in glass containers are intended as a ready-to-eat commodity. Glass fragments originating from other sources must be addressed, where applicable, in a prerequisite sanitation program.

Physical Hazards

• *Metal Fragments*

Metal-to-metal contact—especially in mechanical cutting and blending operations, and with equipment that has parts that can break or fall off, such as wire-mesh belts—can introduce metal fragments into products. Such fragments serve as a hazard to the consumer. This hazard can be controlled by subjecting the product to metal detection devices or by regular inspection of at-risk equipment for signs of damage.