North Central Regional Aquaculture Center

Fact Sheet Series

Instilling a Culture of Safety in Aquaculture

Safety risks associated with aquaculture

First, several definitions must be addressed. According to the United States Department of Agriculture's (USDA) most recent definition, an aquaculture farm is any operation that sells or distributes $1,000 or more in aquaculture products, for conservation, enhancement, or recreation during a particular census year. The USDA also defines aquaculture as the "farming of aquatic organisms, including: baitfish, crustaceans, food fish, mollusks, ornamental fish, sport or game fish and other aquaculture products." Aquaculture farming involves some form of intervention in the rearing process, such as seeding, stocking, feeding, or protection from predators. In this definition, aquaculture farming implies ownership of the stock being cultivated in a controlled environment during at least part of their productive life. Any other aquatic products caught or harvested from non-controlled habitats are termed wild-caught.

Although agriculture and aquaculture share many common safety risks, some are specific to each sector. Crop and livestock farm workers face numerous safety, health, environmental, biological, and respiratory hazards. These include vehicle rollovers (e.g., tractors and four wheelers), heat exposure, falls, musculoskeletal injuries, use of hazardous equipment, silos, unsanitary conditions, chemicals, and many others. In 2011, for example, accidents with vehicles caused close to half (276) of the 570 fatalities reported in agriculture production. Deaths and injuries from falls remain a major hazard for farmworkers according to the Occupational Safety and Health Administration (OSHA), with a non-fatal fall-related injury rate of 48.2 per 10,000 workers in 2011. Other activities characterized by prolonged repetitive motions in awkward positions can result in musculoskeletal injuries in both general agricultural workers and aquaculture employees. An additional example, shared by both types of employees, involves the use of hazardous chemicals.

Aquaculture, however, entails unique and risky chores that pose added danger, including working around water and working at night. A review of worldwide fatalities associated with aquaculture revealed a high incidence of electrocutions as cause of death. This is to be expected, since water and electricity form a deadly combination. There are no in-depth studies, however, that reveal the incidence of these accidents. A relatively recent review (Myers, M. L., 2010) looked at the fatal accidents and non-fatal injuries associated with aquaculture. As previously mentioned, electrocution was a relatively frequent cause of death, but drowning, crushing-related injuries, hydrogen sulfide poisoning, and fatal head injuries were also noted. The non-fatal injuries reported were similar to those happening in other agricultural settings, such as slips, trips, and falls. Also reported were machine or equipment accidents, strains and sprains, chemical-induced injuries, and fires.

In this same review, there was an assessment of risk factors that led to these safety issues. These included cranes and their potential for contact with power lines. In addition, tractors and all-terrain vehicles were cited as being prone to overturn, particularly when driven over eroded levees or berms. There were also safety risks strictly related to water issues such as rushing water, slippery surfaces, and high-pressure sprayers. Management-related mishaps were also reported to be prevalent in aquaculture, often associated with poorly illuminated areas where night shift activities take place, employees working alone, poor or lacking workplace training, and an absence of personal flotation devices.

OSHA requires that employers provide a safe workplace. Employers must correct hazardous working conditions that could cause injury or death of their employees. Here are some of the most common risks and ways to prevent them.

1. Electrocution

Electricity and water are not a good combination. Both are readily present in aquaculture and oftentimes in close proximity. One of the aquaculture systems where OSHA identified electrocution as a hazard was in pond fish culture. In this context, a pond is any small artificial body of water used to raise fish commercially. Electrocution can happen from direct contact from overhead power lines but also from equipment close to, or even in, the water. In addition, OSHA considers the presence of power cords laying around a potential risk in any fish culture system. Workers should exercise caution when working around power lines or live electrical wires, and should be aware of potential risks around wet areas, including ponds and tanks. This is particularly true when working outside and evaluating damages after a storm. Downed power lines constitute a very dangerous hazard.

These accidents may not only be weather related, but also created by accidentally downing power poles with farm vehicles. Federal regulations require at least 10 feet of clearance when working under power lines. It is safer to work with a co-worker who can check progress and make sure there is adequate clearance. If a power line or electric wire is hit, remain in the vehicle since the tires will help insulate its occupants. Alert other co-workers to stay clear of the area until someone turns off the power. This is crucial – power should always be turned off before leaving the vehicle or attempting any repairs. Employees should always pay attention to potential power line hazards and report them to management.

2. Drowning

This is a risk undoubtedly inherent to working in aquaculture systems. According to OSHA, this is one of the three most frequent hazards in pond culture (the other two being electrocution and crushing). Although ponds and tanks can have variable depths, they can often be more than six feet deep. Drowning is not typically just the result of an individual falling into a tank or pond. For example, a tractor or all-terrain vehicle flipping over on a soil berm or concrete wall can easily end up in the water, knocking the worker unconscious or pinning them under its weight. A situation that could result in a non-fatal injury for an agricultural employee on land can rapidly turn into a drowning fatality when working in aquaculture. In tank systems, OSHA has identified additional risks that may result in drowning

such as walking raceways alone at night, deteriorating walkways, absence of railings, algae growth or ice on work areas, and trip hazards.

Drowning is not only a hazard for aquaculture operators but also for individuals not affiliated with the operation, such as visitors, technicians, family and, particularly, young children who may venture close to tanks or ponds out of curiosity. It is very important to surround fish-rearing bodies of water with a perimeter fence that limits the access of unsupervised or unintended visitors. Ponds and tanks should always have "No Trespassing" signs posted around the perimeter. Throwable life preservers, with 100 feet of rope, should be mounted throughout the operation where they are clearly visible.

3. Crushing-related injuries

Crushing happens when a part of the body is caught between two surfaces that are being pushed together with high pressure. Crushing can result in broken bones, lacerations, bruising, bleeding, shock, and eventually death. Crushing injuries are common when structures or vehicles fall on a worker or when equipment traps a part of their body. Since some crushing injuries can interrupt blood flow to the affected area, permanent nerve damage or an infection can result which might require amputation of the extremity. When a crushing incident is minor, it may just be enough to thoroughly wash any wounds in the affected area to avoid infection. Ice applied to the injured area can reduce inflammation and pain. In severe cases, do not dismiss the possibility of a fracture and have the employee seek immediate medical attention.

4. Hydrogen sulfide poisoning

Hydrogen sulfide can occasionally present serious toxicity risks in aquaculture settings. Its presence is the result of some sulfate-reducing bacteria (e.g., *Desulfovibrio*) commonly found in aquatic environments (usually sediment) with high levels of organic material, as well as in waterlogged soils. While considered anaerobes in the past, *Desulfovibrio* and other sulfate-reducing bacteria are facultative anaerobes (aero-tolerant). They can survive in oxygen-rich environments but grow more efficiently in its absence. However, when there is no free oxygen available, they use the oxygen present in the sulfate molecule for their metabolism, reducing it to hydrogen sulfide. Hydrogen sulfide is toxic to both animals and humans since it interferes with respiration. In aquaculture, its presence is associated with high concentrations of organic sediment (e.g., uneaten food and excreta), which allows these bacteria to proliferate.

Its health effects in humans vary depending on the susceptibility of the individual, its concentration in the air, and exposure duration. If the exposure is constant, it can affect health at lower concentrations. Those that suffer from acute or chronic respiratory conditions should not work, even sporadically, in areas where there is hydrogen sulfide production potential (e.g., cleaning sediments). At low concentrations the first signs of toxicity are irritation of the eyes, nose, throat, and respiratory system (e.g., tearing of eyes, cough, shortness of breath). However, the effects can be delayed, even for days. Moderate concentrations can cause severe eye and respiratory irritation such as a cough or difficulty breathing, headache, dizziness, nausea, vomiting, staggering, and excitability.

According to OSHA, entering an atmosphere with a concentration of hydrogen sulfide above 100 parts per million (ppm) is immediately dangerous to health and potentially life threatening. If there is an absolute need to work under these environmental conditions, workers should wear a full face-piece pressure demand self-contained breathing apparatus, with a minimum service life of thirty minutes. An alternative is a combination of a full face-piece pressure demand supplied air respirator with an auxiliary self-contained air supply. At concentrations below 100 ppm, an air purifying respirator that is fitted with a filter cartridge or canister appropriate for hydrogen sulfide can be used. If using only a half-mask respirator there is a need to also wear tight fitting goggles.

Portable sensors that alert workers of dangerous air concentrations of hydrogen sulfide are available. The smallest and most affordable types are the size of a key fob and weigh less than one ounce. Their range is from 0.0-50.0 ppm, with a first alarm sounding at 10 ppm and a second at 20 ppm. Most also have an eight-hour time weighted average alarm (TWA) at 10 ppm, which allows the worker to assess how long they were working under lower concentrations.

5. Fatal head injuries

Fatal head injuries can happen as a secondary outcome of almost any of the accidents reported above. However, when working in situations where there is an increased possibility for head injuries to occur, hard hats or helmets should be considered. Any instance where an employee falls or slips and hits their head against a hard object, or when a moving hard object impacts their head, or when loss of consciousness results in the employee falling to the ground can prove to be fatal. Keep in mind that a hard blow to the head always has the potential of turning into a fatality, even if not immediately. If an employee loses consciousness after hitting their head, they require further medical evaluation to make sure the injury does not progress to something more serious. Never accept a worker's "I am fine" statement, nor their willingness to return to work immediately. Take workers who have suffered a head injury to the closest clinic immediately.

6. Non-fatal injuries slips, trips, and falls

Non-fatal slips, trips, and falls are the most common source of workplace injuries, and they make up the greatest number of workers' compensation claims. Serious injuries include sprains and strains. Water spills, algae build-up on concrete surfaces, and inadvertent oil spills in machine shop buildings can all make surfaces slippery. During cold weather, ice may form on indoor and outdoor surfaces. Tripping, in contrast, happens with different floor levels, broken concrete, and obstacles, including uneven walking surfaces and protruding pipes or hoses. In addition, people working on roofs and platforms or climbing on equipment are at risk for falls. Some prevention rules to avoid slips, trips, and falls include:

- Cover drains or drainage holes with firm, flush-fitting grates.
- Clean up spills immediately.
- Update lighting and ventilation in older facilities to increase visibility, aid in floor drying, and inhibit algae growth.
- Secure hoses and other obstacles to walls and make sure they are out of the way.
- Discourage using the bucket of a front-end loader instead of a ladder.
- Employ practical methods of de-icing floors or walkways.

7. Accidents involving machines and equipment

Accidents involving machinery and equipment happen in every farm, and aquaculture is no exception. Employees should receive proper training before operating any type of machinery. In addition, workers should be in the proper mental and physical condition to do so. Impairment because of drugs, alcohol consumption, or medication side effects could result in otherwise preventable accidents. Workers should also wear protective clothing adequate for the type of equipment operated. Machines with rotating parts can easily catch loose clothing and pull the employee into the mechanism. If dealing with motorized vehicles, remember they are generally designed for one person to drive and operate. Avoid having additional individuals riding along, and never use the bucket of a skid loader or tractor in place of a ladder to lift up a second operator.

Workers or visitors who are not trained or licensed to operate certain equipment should not be allowed to use those machines. Always

remember that they have not had the training on the potential risks of that machinery and equipment, and are likely not wearing the required protective clothing or equipment.

All employees should know how to operate and perform maintenance on the equipment under their responsibility. Even if they have worked with these machines or other devices for a long time, there is no excuse for shortcuts or modifications to established protocols. Turn off all pieces of equipment when they are going to be serviced or repaired. When servicing a motorized vehicle, park it on level terrain, turn the engine off, engage the brakes, and make sure the transmission is not in neutral. The importance of having rollover protection is addressed later in this document.

8. Noise

Continued exposure to loud noises destroys nerve endings in the inner ear and results in hearing loss and the development of other auditory impairments such as ringing in the ears (tinnitus), difficulty hearing conversations in the presence of background noise, or localizing where sounds come from. Additional exposure will result in the loss of more nerve endings, which do not regenerate. The result is permanent hearing loss that cannot be corrected by surgery or medicine. Exposure to persistent high noise levels is also associated with stress, cardiovascular disease, and reduced job performance. In addition, some chemicals such as heavy metals, organic solvents, and engine exhausts pose toxicity to the ears or increase sensitivity to noise. Chemical exposures in aquaculture, including pesticides, have been identified and may be ototoxic (e.g., organophosphates, paraquat, pyrethroids, and hexachlorobenzene).

To make matters worse, 27% of workers in the agriculture, forestry, fishing, and hunting (AFFH) sectors reported not wearing hearing protection when working in loud noise areas. National Health Interview Survey (NHIS) data has shown that nearly 80% of all AFFH workers suffered from hearing difficulty, tinnitus, or both conditions. Aquaculture by itself had the highest adjusted risk of all AFFH workers.

With the notable exception of the work of Barnes et al. (2015), most studies on the effects of noise in aquaculture were conducted in Europe. In Barnes' study, noise levels in a salmon building rose from 43.2 decibels (dB) without any flowing water to 77.5 dB with water flowing to all six in-ground tanks. Ambient noise levels in the hatchery tank room ranged from 50 dB when water was not flowing to more than 73 dB with water flowing to all 35 tanks. On average, noise exposures ranged from 64-68 dB (depending on the rearing facility) routinely peaking to 73-77 dB intermittently, with no noise controls implemented. OSHA requires that when any employee's exposure may equal or exceed an eight-hour time-weighted average of 85 decibels, the employer must develop and implement a hearing monitoring program.

Typical noise levels may not cause hearing loss by themselves, but may change worker's behavior such as encouraging the use of higher volume headsets to reduce the background noise. Another aspect that can alter noise is the presence of more fish tanks or variations in building construction. Inexpensive control solutions that reduce noise exposures include partially covering fish tanks and using standpipe covers. Placing partial tank covers over the top of the tanks above the water inlet significantly reduced noise levels. For the greatest noise reductions, researchers reported the use of covers for both tanks and standpipes. Regenerative blowers are another common noise source in aquaculture facilities. While the noise from blowers can be reduced to some extent using mufflers and enclosures, they should be installed away from work areas or partitioned off in such a way as to reduce impacts on workers while being careful to avoid overheating or restricting airflow.

In spite of all these measures, it is highly recommended for employees to wear noise-cancelling headsets at all times when working in noisy areas. Employers should discourage the use of headsets that play music since prolonged high volumes to offset the background noise is likely to result in hearing impairment over time. One other helpful tip is for workers in those areas not to exceed eight-hour shifts and to rotate workers often to areas where there is less noise contamination.

9. Strains and sprains

Sprains and strains are a frequent injury in both the street and the workplace. They are common injuries with similar signs and symptoms, but occur in different parts of the body. A sprain occurs when there is a stretched or torn ligament. On the other hand, a strain is an injury to a muscle or tendon that connects a muscle to a bone. The most frequent location for strains is the lower back or the hamstring; sprains on the other hand frequently are located in the ankle.

Uneven or slippery surfaces as well as items scattered on the floor are frequent causes of strains. Sprains happen when a sudden, unexpected movement occurs or when carrying excessively heavy loads. In both cases, the recommendation is to apply cold to the affected area until the inflammation subsides.

10. Chemicals

In one visit to a tank-based aquaculture facility, OSHA identified a number of potentially hazardous chemicals such as hydrogen peroxide, including open drums of some chemicals. Other chemicals that posed hazards for potential exposure were lime, liquid oxygen, oxyacetylene, fuels and solvents, and muriatic acid. When working with chemicals, personnel should take the time to protect themselves with proper attire such as coveralls, rubber gloves, goggles or face shields, respirators, and appropriate footwear.

Transport and storage

- All chemicals should be stored in a locked chemical locker or shed (apart from the work area) when not in use. This storage area should provide spill containment and ventilation.
- Chemicals used should always be inaccessible to children, visitors, and inexperienced or untrained personnel.
- Store veterinary chemicals that require refrigeration in a separate refrigerator not used for drinks or food.
- Clearly label acids and alkalis and distinguish them from each other. Never mix them together because mixing causes a violent reaction.

Have chemicals delivered to the farm by a professional; avoid involving farm personnel in this task.

Decanting, mixing, and use

- Mix chemicals in a ventilated area on a non-porous surface that is easy to clean, and with close access to clean water for washing spills, personal cleaning, or first aid.
- Use pumps, siphons or gravity taps to move chemicals from a drum. Pouring the chemicals risks spills and splashing. Closed automated delivery systems are also available.
- Install hand-held soft water showers. Place them where detergents are decanted and use them for removing chemicals from the eyes.
- An employer is responsible for providing, maintaining, and replacing, when necessary, all protective equipment.
- Employees are responsible for wearing protective equipment when working with chemicals. They should exercise care with equipment, maintain it, and return it to its original location.

Handling of chemicals

Every aquaculture farm should have a formal management plan to deal with chemical emergencies or spills. This plan should include emergency and first aid contact phone numbers including, but not limited to, local 911 responders. Enact workplace rules for the use of chemicals, and make sure all workers follow them. Train workers who need to use chemicals, particularly restricted chemicals, through a suitable program. Material safety data sheets (MSDSs) should be available for all chemicals present at the facility. These sheets are generally available from the supplier, but they can also be located from a number of online sources.

Always ask yourself if a particular chemical is necessary, or if there is another safer and more environmentally friendly alternative. When dealing with chemicals Francesa et al. (2011) suggested following what they labeled the "Hierarchy of Control." It consists of an established process to identify the most effective way to control chemical risks (including hazardous substances) from most-effective to least-effective.

i. Elimination: Stop using and remove the chemical.

ii. Substitution: Replace the chemical with a less hazardous substance.

iii. Isolation: Separate the chemical from people (e.g., metal cabinets).

iv. Engineering controls: Use automated equipment to reduce potential contamination.

v. Administrative controls: Establish specific procedures to handle the chemical.

vi. Personal protection equipment: Require protective equipment (e.g., goggles, respirators, etc.).

11. Fires

Three common sources of fires are cigarette smoking, improper storage of flammable liquids or their vapors, and electrical failures. Smoking in the workplace should be discouraged, not only for health reasons, but because of the risk of causing a fire. There is always the risk of stray sparks or lit ashes landing on gasoline, paper, lint, or some other easily flammable source that can initiate a fire.

Improper storage of flammable chemicals may also lead to fires. There are strict standards published by OSHA regarding storage, transportation, and handling of flammable chemicals to reduce the risk of fires in the workplace. Fish farm owners and managers should familiarize themselves with these standards to make sure they are in compliance.

Electrical failures are also a common cause of fires. Plugging too many devices into one outlet, using worn or non-suitable extension cords, and not properly grounding electrical equipment may all result in fires on the farm. Protect electrical panels from workers touching them by accident or from water being sprayed on them.

Preventing fires

- Immediately clean up oil, gasoline, and other flammable liquid spills.
- Keep OSHA and National Fire Prevention and Control Administration (NFPCA) approved fire extinguishers in all areas where there are potential risks (e.g., warehouses, storage areas, fuel dispensing areas). Make sure all employees know where they are and how to use them.
- Prohibit cigarette smoking indoors.
- Have electrical wiring and equipment installed and maintained by a licensed electrician.
- Keep flammable chemicals and liquids in fireproof cabinets.

12. Tractors, all-terrain vehicles, and forklifts

Tractor rollovers are the most frequent accident in agriculture, and the leading cause of deaths. A rollover happens when a tractor on an incline tips sideways or backward and turns upside down, often crushing the worker beneath. This also occurs during sharp turns at speeds greater than normal, causing the tractor to shift its center of gravity to one side. The center of gravity in a tractor is higher (top heavy) than in a car or pickup and sharp turns make them tip over more easily. Also depending on the type of tractor, its back half may represent up to 2/3 of its total weight, making flipping over more likely. This is even worse if the tractor is fitted with a raised front loader, which causes an even greater shift in the weight toward the rear.

Tractors working on or near pond berms or levees in aquaculture settings pose an additional threat, since both the tractor and operator risk falling in the water. An otherwise non-fatal pin or blow causing unconsciousness while on land can result in drowning when in the water, even in shallow depths. Similarly, when driving too close to the water's edge, the bank can tear and collapse from the tractor's weight, causing it to fall into the water.

Preventing near rollovers

- Never hitch a towed load higher than the tractor drawbar.
- Use front chassis weights to counterbalance heavy rear-mounted implements.
- Always start forward motion slowly.
- Backing down a grade (as is often necessary when deploying emergency aerators) is risky, and the faster the speed and steeper the slope, the greater the potential to flip over. Always back down steep grades in a low gear, so the need to hit the brakes (which can cause the tractor to flip) is less likely. Whenever possible, back tractors up steep slopes, and come down forward.
- If a tractor starts rolling backward down a steep grade with the clutch disengaged, engaging the clutch is almost the same as braking, which could result in a backward flip. If possible, let the tractor roll to the bottom of the slope without applying the brakes or engaging the clutch.
- Never try to cross ditches, drive around them. If the drive wheels lodge in a ditch, back the tractor out.
- Back tractors out if stuck in the mud. Putting boards or logs in front of the drive wheels has caused backward flips.

Rollover protective structures (ROPS)

Modern farm tractors are fitted with rollover protective structures (ROPS). Their design minimizes injury potential in a rollover. In a ROPS-equipped tractor, it is critical to fasten the seatbelt securely. Should a rollover occur the belt is the safeguard that holds the driver within the protected area. Do not wear a seatbelt in tractors without ROPS, since the belt eliminates any chance of jumping to safety should an overturn happen.

Power take-off safety practices (PTO)

Recognize the PTO shaft turns at speeds faster than our reaction time. It is easy for a turning PTO shaft to snag a worker. Follow these guidelines to prevent entanglement:

- Keep all components of PTO systems shielded and guarded.
- Regularly test driveline guards by spinning or rotating them to ensure they have not become stuck to the shaft.
- Disengage the PTO and turn off the tractor before dismounting to clean, repair, service, or adjust equipment.
- Always walk around instead of stepping over a rotating shaft.
- Always use the driveline recommended for your machine.
- Position the tractor's drawbar properly for each machine used to help prevent driveline stress and separation on uneven terrain and during tight turns.
- Avoid tight turns that pinch rotating shafts between the tractor and machine, engage power gradually, and avoid over-tightening of slip clutches on PTO-driven machines.
- Lock the PTO driveline securely to the tractor PTO stub shaft.
- Keep universal joints in phase (check the operator manual or talk with a farm implement dealer).
- Wear adequate, close-fitting clothes and avoid loose clothing that hangs freely or blows in the wind.
- Stop the tractor and disengage the PTO to work on it.
- Secure long hair under a hat when working around a PTO.
- Instruct all operators about the hazards of a PTO.
- Keep children away from all turning parts of the machine, not just the PTO.

Forklift Hazards

OSHA has identified forklift hazards as accidents frequently associated with aquaculture farms. The incidence, however, seems not as high when compared to other industries. There are over 850,000 forklifts in the U.S., and more than 95,000 forklift-related accidents occur annually. Among those accidents resulting in death, the three most common situations are forklift overturns, pedestrians being struck by forklifts, and workers being crushed by forklifts. AFFH typically represents less than 10% of that total. It is a violation of federal law for anyone under 18 years of age to operate a forklift, and anyone over 18 years of age must complete a training course and be legally certified.

13.Rushing water, slippery surfaces, and high-pressure sprayers

Falls on slippery surfaces are one of the most frequently occurring accidents that lead to personal injury. While these accidents can result in minor bruising, they are not devoid of major risks, such as fractures, concussions, and even death in extreme circumstances. Slips happen when there is not enough traction between the footwear and the walking surface. Wet spots, ice or snow, oil or grease, or any other substance that reduces traction can further complicate problems. It is easy to understand how surfaces can become frequently slippery in fish farms. Objects scattered on the floor (e.g., hoses, brushes) and running water can increase the chances of losing one's step.

The following are guidelines (modified from OSHA) to prevent slips and falls or minimize their consequences:

- Wear personal protective equipment such as hard hats, gloves, safety footwear, and eye protection.
- Be aware of hazards that may cause slipping or falling.
- Keep all work areas, walkways, and stairs tidy and clear of oil, grease, tools, and debris.
- Use rubber or other non-skid flooring surfaces if possible.
- Provide guardrails and side guards around areas prone to slips, trips, and falls.
- Install, inspect, and secure stairs and handrails.
- Keep cords and hoses clear of walking spaces.
- Conduct regular inspections to identify and correct hazardous work surfaces.
- Use waterproof footgear to decrease slip or fall hazards.

14. Faulty management-related mishaps

Aquaculture owners and supervisors should avoid four key elements:

1. Poor or absent in-the-workplace training.
2. Absence of personal flotation devices and other safety gear.
3. Poor illumination where night shift employees work.
4. Employees working alone.

Cold weather operations

It is not uncommon to work on and around frozen ponds during the winter in the North Central region. All workers should be familiar with the signs of hypothermia and how to respond, including CPR, before cold weather hits. When it is necessary to measure water quality through the ice, for example, always work in teams of two or more, with one person on the ice wearing a flotation device while the other(s) remain on the shore. There should always be a rope extended between the person on ice and those on the shore. It is advisable to drill test holes through the ice while moving cautiously from the shore in order to monitor ice thickness. When working on the ice, always have a vehicle nearby with a warm cab, thermoses with a warm, sweet non-alcoholic drink, and dry towels and blankets. If bubbling aeration is deployed in a pond, there should be no further work on the ice for the remainder of the winter. The same precautions apply when harvesting open ponds in cold weather, where waders can fill with very cold water or workers can slip and fall into the pond.

First aid and emergency response

Since fish farming includes safety and health risks, it is important to put in place a plan for an effective response to any incident. Employees should know what to do and how to seek help in an emergency such as fire, trauma, electrocution, drowning, hypothermia, or heat stroke. Develop emergency response procedures, program occasional drills, and learn from them.

Some basic items to look after when exploring emergency response procedure planning are:

- Clearly identify the location of fire extinguishers and have them regularly inspected.
- Post names of trained first-responders.
- Avoid working alone, particularly at night.
- Use reliable communications systems to transmit clear information as to where to locate injured personnel.
- Have at least one portable first-aid kit and at all times a first-response person trained to assist anyone injured. Everyone should know this individual's name and how to contact them.
- First-aid kits should include disposable resuscitation masks and nitrile gloves.
- Send employees to first-aid training courses. A worker who is seriously injured has the best chance for surviving if assisted immediately. Workers should know how to administer CPR and be prepared to deal with shock, heat exhaustion, heat stroke, poisoning, and hypothermia.
- All workers must know how to immediately contact the first-response person and local 911 dispatchers. Encourage workers to use water-resistant cell phone protectors and to maintain regular contact throughout work hours.

Useful resources for more information

Barnes, M.E., C. R. Hewitt, and T. M. Parker. 2015. Fish Hatchery Noise Levels and Noise Reduction Techniques. Journal of Agricultural Safety and Health. 21(3): 187--95. (doi: 10.13031/jash.21.11072)

Collins, J. W., Kisner, S. M., Johnston, J. J., Chin, S. F., and Kennedy, R.D. 1999. Fatal occupational injuries associated with forklifts, United States, 1980–1994* https://doi.org/10.1002/(SICI)1097-0274(199911) 36:5<504::AID-AJIM2>3.0.CO;2-P.

Francesa, U.; Keown, J.; Endres, M.; Mondak, C., and Garcia, A. Safety Risk Areas at the Dairy Farm. 2011. http://openprairie.sdstate.edu/extension_fact/150.

Masterson, E. A., C. L. Themann, and G. M. Calvert. 2017. Prevalence of hearing loss among noise-exposed workers within the agriculture, forestry, fishing, and hunting sector, 2003-2012. https://doi.org/10.1002/ajim.22792.

May, J.J. 1999. Occupational hearing loss. The New York Center for Agricultural Medicine and Health, The Mary Imogene Bassett Hospital, Cooperstown, NY.

Myers M.L. 2010. Review of occupational hazards associated with aquaculture. Journal of Agromedicine. Oct; 15(4):412-26.

Quandt SA, Kucera KL, and C. Haynes. 2013. Occupational health outcomes for workers in the Agriculture, Forestry and Fishing Sector: implications for immigrant workers in the Southeastern U.S. American Journal of Industrial Medicine. 56:940-959.

Theman, C., Suter A. H., and M. R. Stephenson. 2013. National Research Agenda for the Prevention of Occupational Hearing Loss – Part 1. Thieme Medical Publishers 333 Seventh Avenue, New York, NY 10001, USA.

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