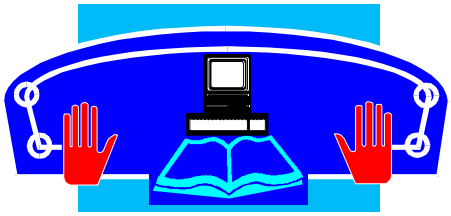


Alberta Fish And Wildlife; Game Fish Farming Facts Sheets Nos 1-13 Fisheries, Acquaculture General
Author: Gov't Of Alberta
Catalogue Number: 3-28-13

Alberta Fish & Wildlife
YOUR PARTNER IN CONSERVATION

Game Fish Farming Fact Sheet No. 1

CAPITAL AND OPERATING COSTS OF TROUT FARMING

Prospective fish farmers should be aware of the costs involved in raising trout.

Extensive Fish Farming

If you are raising fish in a pond, stocking small fish and harvesting them later when they have grown on the natural pond food, you are using a technique known as extensive fish farming. Regardless of whether you are a hobby or a commercial fish farmer, you will have capital costs; but these are limited to the purchase of stock, gill nets for harvesting, and a boat if your pond is large. If your pond water contains little oxygen at some times of the year, you may have to buy an aerator to add oxygen. If you must harvest fish from under ice in the winter, you would need to get an "ice jigger, " a device that is used to set gill nets through holes in the ice. Of all of these costs, fish stock will be the highest unless you must construct a pond first. Construction costs for ponds will vary from case to case.

Operating costs for extensive fish farming vary greatly depending on the scale of your operation. Some ponds are subject to heavy growths of algae and you will have to control these with chemicals. If you run boats or aerators, you will have to pay for their operation. Commercial fish farmers will often have to employ help to assist with harvesting and processing fish for sale.

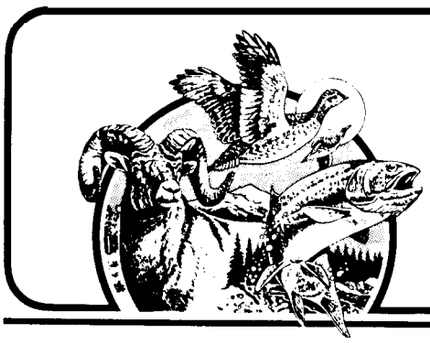
Intensive Fish Farming

Hobby fish farmers are advised to limit themselves to extensive fish farming. Because extensive fish farming allows very little opportunity to affect fish growth and survival to maximize production, another technique known as intensive fish farming, is usually used by commercial fish farmers. There are several ways of doing intensive fish farming.

Cage culture confines high numbers of fish in large cages that float in lakes. This allows the fish farmer to use large lakes, but also allows close control of the fish and allows feeding to increase growth. Capital costs will be similar to extensive fish farming, with the addition of the cost of the cages and floats. These can be very high. The cages keep fish from foraging on natural lake food so fish must be fed by hand or automatic feeders.

The greatest operating cost in cage culture, and in all intensive fish farming, is the cost of feed. This can account for up to 80% of all operating costs. Another high cost is that of disease control. Fish are crowded together in cage culture and this causes some stress which, in turn, makes fish more susceptible to diseases. These diseases spread rapidly in crowded cages so continuous disease monitoring is needed and prophylactic or curative treatments to prevent or cure disease may be required.

The most elaborate type of intensive fish farming is **raceway culture** in which fish are raised in channels, usually made of concrete, fed artificial food, and provided with warmed waters. The capital costs of raceway culture can be massive because of the engineering and concrete work needed as well as the various support facilities. For example, water pumping and piping may be needed and the water may have to be heated. If water is in short supply, it will have to be re-used several times which requires filtering and aeration equipment. If the fish farm is large, it can cause significant pollution by discharging fish wastes and uneaten food; a water treatment plant will be required. Operating costs will probably be higher than for cage culture because raceway culture needs more maintenance.



Alberta Fish & Wildlife

YOUR PARTNER IN CONSERVATION

Game Fish Farming Fact Sheet No. 2

MARKETING RAINBOW TROUT

The holder of a Commercial Game Fish Farm Licence is permitted to harvest and sell fish from the licenced fish farm. Such sales fall under the jurisdiction of the Freshwater Fish Marketing Corporation (FFMC). In Alberta, the FFMC oversees the marketing and exporting of all fish, including rainbow trout, according to the federal Freshwater Fish Marketing Act and the provincial Fish Marketing Act. Under the provisions of the Fish Marketing Act, game fish must be sold to the consumer, to the FFMC or to retail outlets (with special permission). The licensee should consult the Fish and Wildlife Division and the FFMC to obtain specific regulations and provisions for packing, transporting and selling fish.

In the past, the FFMC has shown little interest in marketing farm-produced rainbow trout, and little market development has taken place. It has, therefore, encouraged commercial licensees to market their own fish by granting them exemptions from the provisions of the marketing acts. A commercial licensee may request such exemption by applying to the FFMC for a Special Dealer's Licence, which permits the licensee to sell the fish directly to consumers and retailers. Applications should be sent to:

Freshwater Fish Marketing Corporation
11635-145 Street
Edmonton, Alberta
T5M 1V9
Telephone: (403) 455-8886

Commercial Game Fish Farm Licence holders who receive the Special Dealer's Licence must still comply with other provisions of the acts covering the packaging and transport of fish. The Special Dealer's Licence **must be renewed annually.**

ONLY COMMERCIAL GAME FISH FARM LICENCE HOLDERS MAY SELL OR OTHERWISE TRAFFIC IN FISH. Trout raised and harvested by the holder of a Private Game Fish Farm Licence are for recreation and personal consumption only.

For more detailed information on this subject, contact your Regional Fisheries Biologist, Fish and Wildlife Division, Department of Forestry, Lands and Wildlife.

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Alberta
FORESTRY, LANDS AND WILDLIFE
Fish and Wildlife Division

Alberta Fish & Wildlife
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Game Fish Farming Fact Sheet Nom 3

INTENSIVE TROUT FARMING 1 : SPAWNING AND INCUBATING EGGS

Rainbow trout become ready to spawn in the spring. Mature trout are identified by their soft, flaccid abdomens. To obtain eggs or milt from a fish, grasp it gently by the head with one hand, supporting the body near the tail with the other hand. It is much easier to grasp the fish if woolen gloves are worn. Using gently massaging movements, press the body cavity **lightly** between the thumb and forefinger, starting slightly in front of the vent and sliding toward it. Repeat the motion starting each time slightly nearer the head. If trout are ripe, eggs or milt should come out easily. **DO NOT TRY TO FORCE EGGS OR MILT FROM FISH.** If a fish does not produce these readily, return it to the water and try another fish.

Strip eggs from the female fish first into an enamel or aluminum basin. Add the milt from one or two males and mix the eggs and milt **gently** with a finger or feather. Then let the eggs sit for 10 minutes. Wash the fertilized eggs by gently swirling them in several changes of fresh water, and then set them aside for about three hours to harden in well-oxygenated water. Newly fertilized eggs will be quickly killed by bright sunlight; they should be shaded at all times.

The fertilization process is very sensitive to contaminants; care should be taken to keep water and mucus from dripping into the basin from the fish or the gloves of the handler. Blood and faecal material are especially bad because they increase the chances that bacteria or fungus will infect the eggs.

After hardening, the eggs must be placed in an incubator. Until they have developed to the stage when the eyes of the young fish are visible (the eyed stage), eggs are very fragile and may be killed by sudden shock or jarring. Dead eggs can be distinguished easily by their white opaque colour and should be carefully removed several times a week to prevent fungus becoming established in the incubator.

Most large trout hatcheries incubate eggs on wire mesh trays stacked in troughs with high water flow. An alternative, which uses less water and is particularly suited for culturing smaller numbers of eggs, is the drip incubator. By this method, eggs are covered with a thin layer of water which constantly drains from the tray. A simple drip incubator can be made from shallow (15 cm) plastic tubs with many small (1 mm) holes drilled in the bottom. Three to five of these are stacked one above the other. The top tub should act as a header tank, into which water is run from a supply line at a rate equal to the rate of drainage from the tank. The egg trays should have a screened overflow to provide maximum water depth of about 10 cm and the tray bottoms should be lined with a 3-5 cm layer of coarse gravel. No more than two layers of eggs should sit in each tray. This allows for good water circulation, and makes it easier to remove dead eggs without disturbing healthy ones.

The eggs should be disinfected daily to inhibit growth of fungus. One possible disinfectant is malachite green. A solution of 5 parts per million (0.005 g of chemical dissolved in 1 L of water) should be allowed to flow over the eggs for 15 minutes every day. Be sure to use only malachite green that has a low zinc content. Specify that you want “low zinc” malachite green. Malachite green can cause cancer so care should be taken when handling it. A safer alternative is a solution of formalin. The formalin as purchased should be diluted to a 37% solution by mixing the chemical with water in a ratio of 1 mL of chemical to 2.7 mL of water. When ready to treat the eggs you must dilute this solution further to 1800 parts per million by mixing it with water in a ratio of 1 mL of chemical to 555 mL of water. This final solution should be allowed to flow over the eggs for 15 minutes every day.

Alberta Fish & Wildlife
YOUR PARTNER IN CONSERVATION

Game Fish Farming Fact Sheet No. 4

INTENSIVE TROUT FARMING 2: REARING TECHNIQUES

Grading

Fingerling trout tend to grow at variable rates, especially under crowded hatchery conditions. It is therefore necessary to grade trout frequently by size, and raise different-sized fish in separate facilities. At high temperatures, rapidly growing trout may need to be graded as often as once a month; but grading at 8-10 week intervals is usually sufficient.

A simple mechanical grader consists of a wooden box 20-25 cm deep, open on top, with screened sides, and a bottom of evenly spaced aluminum or brass rods. When the grader is suspended in a pond or tank, fish will attempt to swim through the bars to the bottom. Larger fish which cannot do so remain in the grader. Different rod spacings will be needed to grade different fish sizes.

Feeding

Swim-up trout, after they have exhausted the yolk sac, must be taught to accept prepared food. This requires considerable patience on the part of the feeder, using small amounts of food. Fish can be fed by hand, but timed automatic feeders or demand feeders will reduce labour costs and food waste, and usually increase feeding efficiency.

Some hatcheries prepare their own feed from a mixture of dry fish meal and fresh meat. It is usually more economical, however, to buy prepared feed pellets. These come in a variety of pellet sizes for different sized fish, and different formulations for fingerlings and large trout.

Facilities

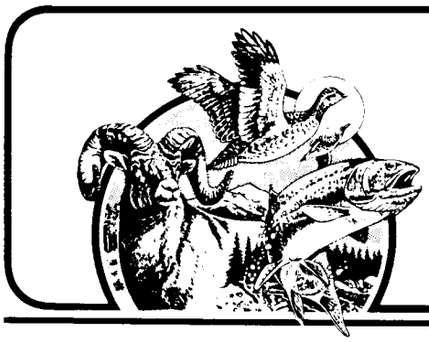
Several types of facilities can be used to rear young trout. Swim-up fry hatched in **incubation troughs** may be raised there for several weeks.

Circular tanks are preferred for rearing fingerlings. Circular tanks have several advantages over raceways or large ponds: they require less water, provide uniform water quality and can sustain greater biomass in a given volume of water. Oxygen consumption is slightly greater in circular ponds, however, due to the relatively high velocity of water flow and the energy fish must expend to swim against it.

Circular tanks are usually 2-3 m in diameter, with variable water depth, made of wood or fiberglass. Water circulates into the tank under pressure from a pipe suspended above the tank surface and flows out through a stand pipe or flat bottom screen.

Large trout are usually reared in **circular pools** (similar to fingerling tanks) up to 12 m in diameter or in **long raceways.** Earthen raceways are less expensive to build than concrete ones, but the walls tend to erode, and aquatic plants will grow along the banks. Some fish culturists prefer earthen raceways because they tend to produce healthier-looking fish. One advantage of raceways in general is that wastes and debris will tend to collect at the downstream end so trout have an opportunity to escape low oxygen/high ammonia conditions. **Large rectangular-circulation rearing ponds** or **Burroughs ponds** (in which water circulates between long parallel concrete tanks) are widely used in big commercial and government hatcheries because they can hold large numbers and fish are evenly distributed throughout the pond. They are, however, very expensive to build.

Regardless of the rearing method employed, rapid water circulation and moderate water temperature are very important. Accumulation of excreted products, especially ammonia, will severely reduce the ability of fish to obtain oxygen. High temperatures aggravate this problem, because a rise in temperature increases the oxygen needs of fish. Under such conditions, fish can suffocate in spite of high dissolved oxygen levels. To avoid this situation, water temperatures should not be allowed to rise above 19°C and ideally should be held between 11° and 15°C. Outdoor facilities can be shaded to prevent this problem. Waterf low sufficient to provide three changes of water per hour will prevent rapid waste accumulation.



Alberta Fish & Wildlife

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Game Fish Farming Fact Sheet No. 5

CAGE-REARING RAINBOW TROUT

In cage culture fish are raised in large cages floating in a pond. This combines the benefits of both pond and hatchery methods. Costs are less than for construction of a trout farm, while the farmer can harvest all the fish stocked.

Cage culture involves three particular problems.

1. Caged trout are forced to live in unnaturally high densities, which may limit their growth rate, and which facilitates the rapid spread of disease.
2. Cages require good water circulation to provide oxygen and remove wastes. Water exchange is particularly important at high temperatures, or during algal blooms, or in sheltered ponds without currents. For many Alberta ponds it will be necessary to rely on aeration or continuous pumping to provide oxygenated water. This increases the operating cost of the farm, and risks the loss of all fish in the case of equipment failure.
3. Caged trout must be fed artificially, increasing both the time and money spent on raising trout.

Cages are usually made of a plastic or nylon mesh suspended in the water from a rigid, floating frame. The frame can be made of aluminum tubing or treated wood, with polystyrene buoys or **clean** metal drums for flotation. To maintain water circulation, use the largest possible mesh size: small mesh sizes clog easily, and may require frequent cleaning to remove algae. Cages should float in water so that the cage does not rest on the pond bottom (restricting water flow). This will also prevent trout from being exposed to water with no oxygen from deep layers of a pond. Caged trout are particularly vulnerable to mink and diving birds, so cages should be anchored away from shore with the top frame securely covered.

The amount of fish which can be successfully raised in a single cage will vary considerably with the size of fish, water temperature and water flow. Because fish are growing continuously, you should maintain the total weight, not the number of fish in a cage. Under ideal conditions, a 1.8 X 1.2 X 1.2 m cage will support up to 200 kg of rainbow trout. This figure should be reduced under conditions of extreme temperature or water stagnation. To maintain the total weight of fish in the cage, you will have to monitor individual fish weights and numbers and then adjust the number of fish.

Caged trout can be fed either prepared trout food (available from a number of suppliers in Alberta, Saskatchewan and the United States) or a mixture of dry meal and fresh meat prepared by the farmer. Food particle size is especially important. Small trout must be fed very small food pellets, or a meal/meat mixture which readily disintegrates into fine particles, so that food is easy to ingest. Larger fish should be fed larger-sized particles, to reduce food waste. It is important to avoid food wastage in cage culture because the uneaten food can accumulate on the pond bottom beneath the cage. The food rots and produces toxic substances and reduces the oxygen content of nearby water.

Feeding rate depends primarily on fish size and water temperature. Use the table below as a general guide, and adjust up or down as necessary.

Recommended Amounts of Dry Food per Day
(kilograms of food per hundred kilograms of fish)

Water temperature	**Approximate fish size (cm)**		
(“c)	5	10	15
5	2.2-2.8	1.4-1.8	0.9-1.1
10	3.4-4.3	2.0-2.7	1.4-1.7
15	5.0-6.0	2.8-3.7	1.9-2.3
20	6.9-9.4	4.0-5.5	2.5-3.2

For more detailed information on this subject, contact your Regional Fisheries Biologist, Fish and Wildlife Division, Department of Forestry, Lands and Wildlife.

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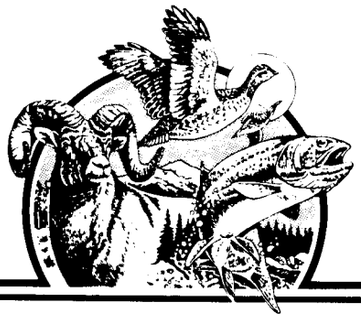
Fish and Wildlife Division



Alberta Fish & Wildlife

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Game Fish Farming Fact Sheet No. 6

PREDATOR CONTROL

Most types of animals that prey on fish are protected and **it is illegal to kill them.** Therefore, only methods that do not harm the predator can be used.

During the first three weeks after stocking, trout are especially vulnerable to predation. You should keep a close watch on the pond during this period and frighten away any predators. Keep a lookout for gulls, loons, kingfishers, herons, bitterns, terns, mergansers, cormorants and mink.

Habitat Improvements

In natural environments, cover where fish can escape from predators is usually plentiful; however, in many dugouts and sloughs cover is limited. These waterbodies can be improved by installing floating rafts (e.g., styrofoam slabs) or submerged brush piles. Note where you place the piles or else you may tangle nets in them.

However, cover along the shoreline can also be used to the advantage of predators. Overhanging trees are ideal perches for kingfishers, and tall grass or deadfalls are good cover for mink. Where possible, all trees and deadfalls should be removed from the shoreline, and grasses around the shoreline edge should be cut.

Deterrent Methods for Specific Species

Wading Birds: The most common predator of farmed trout in Alberta is the Great Blue Heron. These birds wade in the shallows of ponds and spear or grab their prey. They are usually seen fishing in the early morning or evening hours.

Herons are shy birds, but routine feeding habits may include undisturbed trout ponds. They should be frightened away as soon as they are observed. Farmers should be particularly vigilant when fish are 120-250 g because herons prefer fish of this size.

Herons can be most effectively deterred by constructing ponds with steep (70º) or even vertical banks extending at least 35 cm above the water level. This provides wading birds no place from which to catch fish. To stop herons from fishing from the bank in shallow waters, stretch two strands of polypropylene rope, one at a height of 20 cm and one at 35 cm, between posts along the bank. A string of polyethylene floats, spaced 30 cm or less apart on the water around the pond edge, can also be used.

Some farmers have also reported success in chasing away herons using scarecrows. These are usually made from a commercial mannequin brightly clothed and bolted to a plywood sheet with styrofoam floats, set out on the pond.

A particularly effective defense against birds (or any predator) that approach along the banks is a single wire strung about 15 cm above the ground and connected to an electric fence power source.

Mergansers, Cormorants and Grebes: Floating scarecrows are also effective deterrents against diving ducks, over areas of water as large as 6 hectares (15 acres).

Some fish farmers say geese, because of their territorial nature, keep diving birds from ponds. This method could be tried but it is advisable to have only one pair on small water bodies as they will muddy the water.

Gulls and Osprey: As anyone knows who has visited a dump, seagulls become readily accustomed to human activity, and can be difficult to deter from raiding trout ponds. They prey especially heavily on newly-stocked fingerlings. Osprey are less common predators of trout, but may prey persistently on large fish. Some government rearing facilities deter these birds by stringing light-gauge wire on poles above the open water. This may be difficult and expensive for larger water bodies.

General Methods of Deterring Predators

Another method sometimes found effective is suspended aluminum pie plates and bright plastic strips attached to thin poles. This method often works at first, especially in waters that have good wind exposure, but after a few weeks birds and animals become accustomed to them.

Alberta Fish & Wildlife

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Game Fish Farming Fact Sheet No. 7

FISH KILLS AND AERATION

A very common cause of mortality in trout ponds is low dissolved oxygen levels. Trout do best when the oxygen concentration is at least 5 mg/L. They may not survive concentrations below 3 mg/L.

Oxygen enters the pond water from the atmosphere. The photosynthetic activity of aquatic plants and algae also adds oxygen to the water.

In summer, fish kills may occur when an algal bloom grows very large and then dies, leaving a large amount of decaying plant material in the water. Bacteria that consume oxygen as they break down the plant matter deplete or even exhaust the dissolved oxygen supply. The oxygen level also fluctuates dramatically in ponds with large amounts of living algae. These blooms produce a great deal of oxygen during the day, but also consume a large amount of oxygen at night. Trout may experience severe oxygen stress at night in such ponds, in spite of high dissolved oxygen readings during daylight hours.

In winter, fish kills may occur when ice and snow cover the pond and prevent oxygen from entering from the air. The aquatic plants and most of the algae in the pond die, and this decaying material gradually reduces the oxygen supply below that required for trout survival. The decay may produce hydrogen sulphide gas, which has a characteristic “rotten egg” odour.

Regardless of when a fish kill occurs, fresh samples of recently killed fish should be submitted to the nearest Fish and Wildlife office. It is extremely important to find the cause of the fish kill as soon as possible so that corrective measures will be effective.

The risk of fish kills can be decreased by rearing trout in ponds of 5-6 m in depth, and by limiting the growth of aquatic plants. Oxygen can also be returned to the pond water by aeration. A compressor or blower is used to force air through a porous or perforated pipe near the pond bottom. Oxygen diffuses from the rising bubbles into the water. Oil-less diaphragm-type compressors are commonly used, as they are quiet, relatively inexpensive and simple to maintain. For new or drained ponds, the air supply line which feeds the diffusion pipe should be buried below frostline to prevent freezing problems. For existing ponds, the air supply line should be buried at least 30 cm deep, and a spring-loaded, air-type check valve should be placed in the line to prevent water backing up into the line and freezing. To avoid disturbing bottom sediments, which cloud the water and clog the pipe, the air diffuser should be suspended about 30 cm above the bottom.

A typical aeration unit (1/8 HP or larger compressor and 12 mm air supply line) run for 1-2 hours per day after freeze-up will maintain acceptable oxygen levels in most newly constructed small ponds and dugouts throughout the winter. Older dugouts often require continuous aeration because they have accumulated more material during the summer. If a fish farmer has a dissolved oxygen kit and can monitor the oxygen content of the water, periodic aeration may be sufficient. Note that aerated ponds will have a considerably thinner ice cover. Be sure to post warnings, and do not attempt to walk on the ice. A useful guide entitled “Dugout Aeration with Compressed Air” is available from Alberta Agriculture (Agdex 716 BB).

Running the aerator for several hours each week during the summer will keep the pond from developing a bottom layer of water very low in oxygen. Decaying algal blooms may require continuous aeration for several days at a time to replace the oxygen used up by the decomposition of the algae.

In some instances, aeration may not be desirable during the winter. If a pond is to be stocked each year, winterkill will prevent any large trout from surviving to prey on newly stocked fingerlings. Some farmers have also found that it is more economical to stock larger fish in the spring than to nurture fish through the winter by aerating.

Alberta Fish & Wildlife
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Game Fish Farming Fact Sheet No. 8

CONTROL OF WEEDS AND ALGAE

Trout farmers usually find it necessary to control the growth of aquatic plants and algae in ponds. Too many algae and weeds can severely reduce the success of a trout pond. Rooted plants like waterlilies and pondweeds, if they spread beyond the margins of the pond, can interfere with gillnets and reduce their effectiveness. Large amounts of decaying plant material on the pond bottom can also promote winterkill. Algae, particularly the blue-green "grass clipping" alga can grow into large blooms and induce summerkill by using up all the oxygen at night. Individual plants also clump together and die, and rapid bacterial decay uses up the dissolved oxygen in the pond water. However, aquatic plants provide food for the zooplankton which trout consume, and shelter for both the fish and their prey. A healthy fish pond may have about 25% of its surface area covered by water plants.

Steps to control aquatic vegetation can be incorporated into the design of a pond. Algae can be kept to low levels by having good wind exposure, a clean water supply, adequate depth, and some water flow. Rooted plants can be controlled by minimizing shallow areas and building steeply sloping banks, or by using a heavy plastic liner on the bottom of shallow areas.

Permanent control of weeds and algae is only possible if the source of nutrient enrichment is removed. For sloughs and ponds on fertile soil, this is difficult. However, nutrient input from man-made sources (such as cattle or domestic wastes and fertilizer runoff) should be eliminated or reduced.

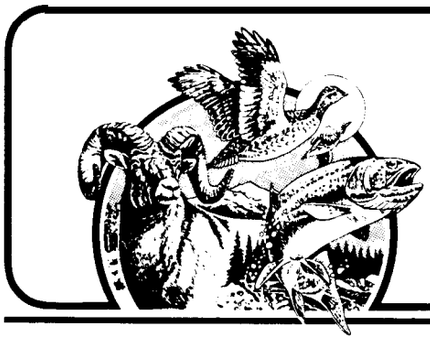
Mechanical Control: Surface weeds and bottom plants can be pulled by hand, mowed or raked while trout are in the pond. This stirs up the bottom sediments so it is important to do sections of the pond on different days so the fish can occupy clean water at all times. All this plant material should be removed from the pond and the area around the pond.

Chemical Control: Many different types of algae, which may turn the pond water green, float on the surface or appear as tiny green crumbs, do not cause summerkill. However when water temperatures approach 18ºC, ponds should be watched carefully for growth of the "grass-clipping" alga. By filling a clean glass jar with pond water and holding it up to the light, the plants can be seen as tiny, 3 mm long, hair-like green filaments suspended in the water. When they grow to 1 cm, treat the surface of the pond evenly with blue stone (copper sulphate) at a rate of 450 g/ha in ponds 2-3 m deep and 670 g/ha in ponds 3-4 m deep. Note that **at higher concentrations, copper sulphate is extremely toxic to fish.** The bluestone is placed in a cloth bag and towed or walked evenly around the pond surface until dissolved. Treating on a windy day provides better mixing. Applying copper sulphate periodically at low concentrations will keep algal growth down and reduce the chance of a massive die-off causing oxygen depletion.

Diquat (Reglone A) is safer to use than copper sulphate because it is less toxic to fish. It is a contact herbicide and can be used to treat large areas or individual plants. It is, however, more expensive. Diquat can be sprayed on the water surface at a rate of 10-20 L/ha and is effective at depths up to 2-3 m.

If the "grass-clipping" algae have already grown to 1.5 cm or started to form 1-2 cm clumps, it is too late to treat the whole pond. This would create a sudden die-off similar to what naturally occurs when the bloom grows and then decays. Spot treatments with a liquid spray of diquat or copper sulphate applied to about one-quarter of the pond at 3-4 day intervals may gradually lower the density of algae without inducing a total die-off. However, the safest way to treat an advanced algal bloom is to allow it to decay while at the same time aerating the water vigorously by spraying or bubbling.

A useful guide entitled "Aquatic Vegetation Management in Alberta" is available from Alberta Agriculture (Agdex 647).



Alberta Fish & Wildlife

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Game Fish Farming Fact Sheet No. 9

STOCKING A POND

Stocking Rate: The objective in calculating stocking rate is to make the best possible use of the rearing potential of the pond without overstocking it. Overcrowding causes lower feeding and growth rates and high mortality rates. The best number of fish for any particular pond will depend on the size of the pond, the size of fish introduced and the productivity of the water. In any case, it is best to understock during the first year, in case some unknown factor kills the fish.

The area of a pond should be calculated at the lowest summer water level. As a general rule, most ponds will support 8-10 cm fish at a rate of 500-600/ha. Similar rates apply for larger fish 15-18 cm or more that are stocked for angling purposes; however, the pond should be fished regularly to prevent the growing trout from outstripping the ability of the pond to support them. Otherwise, no more than 250-300 such fish per hectare should be stocked.

In ponds that do not winterkill, angling will be especially good the second summer. However, these large, older trout will feed on newly-stocked fingerlings, and they become increasingly difficult to catch. Ponds will be used most efficiently if they are fished often and restocked every year or two.

Stocking Technique: High fish mortalities usually occur during the first three weeks after stocking, and frequently these mortalities occur in the first few days because fish were shocked by rough handling or sudden environmental changes. Trout should be tempered to their new environment, and we recommend the following steps to minimize stocking mortalities.

1. Stock fish no sooner than five to seven days after the ice has melted in the spring, to allow time for winds to circulate the pond water and replenish oxygen.
2. If possible, stock fish in the cool hours of late afternoon or evening. This will minimize temperature stress and allow fish to become accustomed to the pond without being exposed to daytime predators.
3. Place the containers in the pond water for about 30 minutes to allow the water temperature inside the container to come to within 2-3°C of the pond temperature, and then gradually add pond water to the container. DO NOT JUST “DUMP THEM IN.”
4. Release the fish well off shore, and distribute them evenly around the pond. This will prevent them from being tangled in shallow water plants or eaten by shoreline predators.

The more patience and care shown during stocking, the greater the chances for a high return.

For more detailed information on this subject, contact your Regional Fisheries Biologist, Fish and Wildlife Division, Department of Forestry, Lands and Wildlife.

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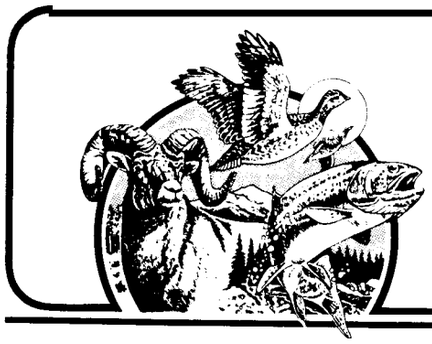
Fish and Wildlife Division



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Game Fish Farming Fact Sheet No. 10

REFERENCES AND SUGGESTED READING FOR FISH FARMERS

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Coche, A.G. 1984. Aquiculture in fresh waters. A list of selected reference books and monographs, 1953-1983. FAO Fisheries Circular 724 (rev.2): 30 pp.
A more extensive reference list, available from the Food and Agriculture Organization of the United Nations, Rome, Italy.

Hilton, J. W., and S.J. Slinger. 1981. Nutrition and feeding of rainbow trout. Canadian Special Publications in Fisheries and Aquatic Science 55: 15 pp.
A technical guide to trout food requirements.

Lawler, G. H., L.A. Sunde, and J. Whitaker. 1974. Trout production in prairie ponds. Journal of the Fisheries Research Board of Canada 31: 929-936.
Describes the initial studies of rainbow trout farming in prairie potholes in Manitoba.

Leitritz, E., and R.C. Lewis. 1980. Trout and Salmon Culture (Hatchery Methods). California Fish Bulletin Number 164. University of California, Berkeley, California.
Describes intensive salmonid culture.

McLarney, W. 1984. The Freshwater Aquiculture Book. Hartley and Marks, Point Roberts, Washington.
An excellent how-to guide for the hobbyist fish farmer.

Roberts, R. J., and C.J. Shepherd. 1974. Handbook of Trout and Salmon Diseases. Fishing News (Books) Ltd., Farnham, Surrey, England.
Describes the prevention, diagnosis and treatment of diseases of cultured salmon ids.

Stevenson, J.P. 1980. Trout Farming Manual. Fishing News (Books) Ltd., Farnham, Surrey, England.
A very general how-to guide.

Periodicals

The American Fish Farmer and World Aquiculture News
American Fishes and U.S. Trout News
Aquiculture
Aquiculture Digest
Aquiculture Magazine
Aquiculture Newsletter
Canadian Aquiculture Bulletin
Canadian Aquiculture Magazine
The Commercial Fish Farmer and Aquiculture News
Developments in Aquiculture and Fisheries Science
FAO Aquiculture Bulletin
FAO Fish Culture Bulletin
Farm Pond Harvest
Fish Farming Industries
Fish Farming International
The Progressive Fish Culturist

There are also four publications by the World Mariculture Society:

Journal of the World Mariculture Society
Proceedings of the Annual Meeting of the World Mariculture Society
Proceedings of the Annual Workshop of the World Mariculture Society
Proceedings of the World Mariculture Society

Note: A few of the listed periodicals may be out of print. Back issues may be available through university, public, or government libraries.

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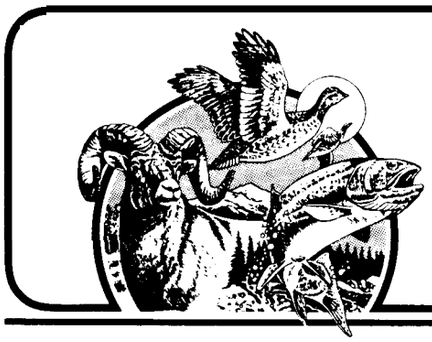

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Game Fish Farming Fact Sheet No. 11

GENERAL WATER QUALITY CRITERIA FOR FISH

The following criteria have been summarized from several sources. They are guidelines only; other parameters not listed may affect water quality (e.g., trace amounts of heavy metals from mineral deposits or of pesticides from farm operations).

The criteria are not legal water quality standards. They are suggested favourable conditions for the culture of fish in general and, where indicated, of rainbow trout in particular.

PARAMETER	DESIRED LEVEL	UNACCEPTABLE LEVEL
Temperature (specific for rainbow trout)	9-13⁰	<0⁰C, >24⁰C*
Dissolved oxygen	80-1000/0 saturation	<5 mg/L*
Carbon dioxide		>25 mg/L
PH	6.5-8.5	<5, or >9'
Total alkalinity	N/A	<25 mg/L $CaCO_3$
Dissolved nitrogen	N/A	>105%0 saturation
Nitrate		>10 mg/L
Nitrite	o	>0.2 mg/L*
Free ammonia	o	>0.08 mg/L*
Ammonium ion	<1.0 mg/L	>3.0 mg/L*
Total phosphate	N/A	>0.1 mg/L
Total dissolved solids	N/A	>1500 mg/L
Suspended solids	<25 mg/L	>80 mg/L
5-day BOD (biological oxygen demand)	⁰	>4 mg/L

● approaching lethal limit at 20⁰C

For more detailed information on this subject, contact your Regional Fisheries Biologist, Fish and Wildlife Division, Department of Forestry, Lands and Wildlife.

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Game Fish Farming Fact Sheet No. 12

WATER QUALITY TESTING

The best way to ensure good growing conditions for your trout is to monitor the water quality of your pond so you can anticipate problems before they threaten the health of fish. Water quality can vary in a number of ways which affect trout, but Alberta trout farmers should be most concerned with changes in temperature, dissolved oxygen, salinity, and pH.

Temperature. Fish farmers can do little to affect pond temperature. However, it is useful to monitor changes in water temperature, because they may indicate changes in other factors. At very high water temperature, dissolved oxygen levels may decline, fish will produce more wastes and growth of algae (as well as fish) will be dramatically increased. Sustained temperatures above 24ºC may be lethal to trout.

Rapid reduction in surface water temperatures may indicate that the cooler water from the bottom of the pond is mixing with the surface water, The bottom water may have low oxygen levels and may contain toxic substances, so the fish farmer should watch his pond closely at these times.

Almost any thermometer can be used to read surface water temperatures. Subsurface temperatures can be measured with a fisherman's thermometer, available from fishing tackle suppliers.

Oxygen. With a few exceptions, there can never be too much dissolved oxygen in a trout pond. Oxygen levels will vary with the temperature, wind exposure and volume of the pond. Deep ponds with poor circulation may develop a bottom layer of cold water containing little or no oxygen.

If you suspect low oxygen levels, test the water regularly, especially during algae blooms or periods of extremely high temperature. Two different test methods are useful.

1. Colourimetric tests (like the popular Hach kits) measure oxygen concentration chemically. They are inexpensive and portable.
2. Battery-powered oxygen meters combine high precision with portability and ease of use, but a reliable meter is very expensive (over $500) and needs to be adjusted frequently.

When choosing a test method, consider the level of precision you will require, the frequency with which it will be used and the cost relative to your overall investment in fish farming. Most hobbyist fish farmers choose Hach kits, or a similar colourimetric test, but more intensive operations might benefit from the speed and reliability of an oxygen meter.

Salinity. Salt concentrations of 1-3 parts per thousand (ppt) are common in central-drainage ponds, but some ponds in southern Alberta occasionally develop much higher salinities. If large amounts of saline water enter a pond as runoff, the only solution is to flush the pond with fresh water. Eliminating potential sources of salt, such as cattle licks and snow cleared from roadways, may help solve this problem.

If you suspect that recurring salt problems are affecting your pond, hand-held refractometers which measure total percentage of salinity are available from the scientific supply houses. These meters cost $150-$200, so be sure you need one before purchasing it.

Rainbow trout can tolerate very saline water (as steelhead trout, they live in 30-35 ppt seawater), but this tolerance is acquired only with gradual changes in salinity. Sudden salinity changes, even of low magnitude, will seriously harm trout. Ponds which consistently receive heavy doses of salt from the shoreline or bottom sediments may have to be abandoned for trout culture.

pH. The pH of Alberta lakes and ponds normally ranges from 6.0 to 9.0 (slightly acidic to moderately alkaline), approximately within the range of tolerance of most fish. Some ponds will have more extreme conditions: those which receive runoff water from acidic bogs may have a much lower pH, while ponds on alkaline soils may have a higher pH. Some ponds may experience wide fluctuations of pH every day.

Like oxygen testing, pH testing can be done with colourimetric kits or electric meters. The chemical tests are inexpensive and easy to do.

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Game Fish Farming Fact Sheet No. 13

EQUIPMENT AND SUPPLIES

Gill net supplies:

Freshwater Fish Marketing Corporation
11635-145 Street
Edmonton, Alberta
Telephone: (403) 455-8886

Leckie's Freshwater Fishing Supplies
14519-121 A Avenue
Edmonton, Alberta
Telephone: (403) 453-3451

McRay's Farm Supply
Lonoks, Arkansas, U.S.A. 72086
Telephone: (105) 676-2766

Nichols Net and Twine Co.
R.R. #3, Bend Road
East St. Louis, Illinois, U.S.A. 62201
Telephone: (618) 876-7700

Some net suppliers also sell ice jiggers.

Water test kits:

Chemonics Scientific Ltd.
14409-115 Avenue
Edmonton, Alberta
Telephone: (403) 451-0665

Sealand Sales Ltd.
2960 West Fourth Avenue
Vancouver, B.C. V6K 1 R4
Telephone: (604) 736-9744

Both of these companies sell the simple, relatively inexpensive Hach Chemical Co. model OX-2P dissolved oxygen test kit which retails for about $110 plus tax.

Trout Feed:

M and H Feeds Inc.
7721-132 Street
Surrey, B.C. V3W 4M8
Telephone: (604) 591-6368

Pay Way Feeds
Division of Intercontinental Packers
P.O. Box 850
Saskatoon, Saskatchewan S7K 3V4
Telephone: (306) 382-3636

Rangen's Trout Feeds
P.O. Box 706
Buhl, Idaho, U.S.A. 83316
Telephone: (208) 543-4338

Silver Cup Trout and Salmon Feeds
Murray Elevations
118 West 4800 South
Murray, Utah, U.S.A. 84107
Telephone: (801) 262-2991

Unifeed Western Pet Foods
Division of United Feeds
P.O. Box 460
Innisfail, Alberta TOM IAO
Telephone: (403) 227-3777

Some rainbow trout suppliers may also be able to provide feed and/or automatic trout feeders,

Most feed suppliers produce a "starter" for fingerlings and a "grower" for larger fish. The starter has a slightly higher protein content and is more expensive. Be sure to get the appropriate feed for your stock.

NOTE: Inclusion in this list in no way implies that the Government of Alberta endorses these companies or that it accepts any responsibility for their business dealings. There may be other suppliers that can provide the same or similar services.

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