OUT OF AFRICA

Aquaculturist Ron Barnes Uses Geothermal Water in Southern Oregon to Rear Tropical Fish from African Rift Lake

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Figure 1. Overview of the 72 15 ft x 100 ft fish ponds near Klamath Falls, OR.

In the harsh temperate climate of southern Oregon, colorful tropical fish from Africa thriving in outdoor ponds are the platform for a successful aquaculture operation—with the help of geothermal waters. Ron Barnes is the energy-wise entrepreneur who is tapping this abundant local resource, commercially breeding thousands of these prized animals for the specialty tropical fish market on the U.S. West Coast and beyond.

A seasoned fisheries expert, Barnes earned a bachelor of science degree in marine biology from the University of California, Santa Barbara, and a masters in aquaculture from University of California Davis. He started out wholesaling tropical fish in Santa Cruz, CA, in 1988, before buying a small—and remote—tropical fish hatchery in 1990. "For me, the operation had a lot of appeal, with room to grow, and especially for its geothermal water," says Barnes.

Located near Merrill in the Lower Klamath Valley (about 10 miles south of Klamath Falls), the hatchery's ponds that Barnes bought are heated with geothermal water that first heat greenhouses at Liskey Farms, Inc. The greenhouse complex consists of four 6,000 square-foot buildings for growing bedding plants and perennials. At peak use, the 1.5-acre greenhouses complex uses 400 gallons per minute (gpm) from six geothermal wells ranging in temperature from 80° to 200°F.

From a 14,000-gallon steel tank salvaged from a railroad car buried atop a hill overlooking the greenhouses, water arrives at the greenhouses at 180° to 185°F. Depending on outside temperature, the water leaves the greenhouses at between 165° and 185°C. Effluent greenhouse heating water is piped to Barnes' original ponds, located adjacent to the greenhouses.

Barnes negotiated leases for the ponds and for purchase of geothermal water from the Liskey greenhouse operation. After getting his feet wet in the business for the first year, he bought 80 acres of land across the road from his original operation, with an established geothermal well. Today, Barnes' operation claims 72 ponds, with 37 located at Liskey Farms, and an additional 35 on Barnes' property across the road.

Breeding stock for the mbuna, peacock and haplochromis cichlids that Barnes raises for market came directly from Lake Malawi, a fascinating and unique biosphere located in the East Africa's Great Rift Valley. For 3,500 miles along the continent's eastern coast, stretching and cracking of the Earth's crust created a legacy of volcanic deposition that formed highlands and enormous troughs. The region hosts numerous geothermal hot springs and fumaroles, and a number of some of the world's largest lakes, including Malawi.

Figure 2. A typical 2" to 4'"blue zebra cichlid.

On a smaller scale, the geology of the East African Rift System where Barnes' fish originated is similar to that of the Klamath Basin in southern Oregon where his breeding operation is located. Like the Great Rift in Africa, the area's geologic structure was formed by stretching of the earth's crust, forming large lake basins—including Upper Klamath Lake, the area's body of water (65,000 acres). Numerous fault blocks thrust up through ancient lake sediments, providing conduits for geothermal water to the surface.

Barnes' fish farm and geothermal wells are located on the flanks of one of these blocks, overlooking the former Lower Klamath Lake, which was essentially drained by irrigation projects in the first half of the 20th century. Some past lake areas are now used for agriculture, while other marshy portions are part of the Klamath Wildlife Refuge—a migration and nesting area for aquatic birds that sometimes zero in on Barnes' ponds for an easy, colorful meal. But he downplays the problem. "Most of the birds that cause trouble are migratory," says Barnes, "and there is someone here almost all the time keeps the birds away."

The operation's geothermal well pumps 300 gpm from 160 feet (Barnes' permit allows 400 gpm). Like the system at Liskey Farms, the operation employs a 14,000-gallon steel tank salvaged from a railroad car for fluid storage and to provide head for no-cost water delivery to rows of fish ponds below. The 100-foot long, 15-foot wide ponds are lined with diatomaceous earth, and are four feet deep. They are set in rows fed with geothermal water from a header pipe distribution system.

In raising tropical fish, water temperature is a key factor in success. Water from Barnes' 210EF well is 197E as it enters each pond via 1 ½" plastic pipe. It quickly mixes with the pond water, causing no harm to the fish, and levels out pond temperatures to an ideal range around 80EF. Barnes experimented with thermostatically controlled valves, but malfunctions overheated the ponds and killed valuable fish. Now he uses manually operated valves that service each pond, maintaining the ponds within a safe, 10E range of the desired 80E temperature.

Figure 3. Ron Barnes on top of the 14,000-gallon steel storage tank salvaged from a railroad car.

The chemical composition of Lake Malawi's water is alkaline, with pH running from 7.8 to 8.5. Fortunately for Barnes' operation, he says, "The water in Lake Malawi is very similar to the water we get from our geothermal wells." Alkalinity is pH 8.8 out of his well, but the chemical composition of pond liners (diatomaceous earth) and soil surrounding the ponds reduce pH to about 7.5 as the water flows through the system. Though this is at the low end of that found in Lake Malawi, Barnes' fish thrive without the use of expensive chemical additives.

Barnes raises more than 100 different varieties of fish, including cichlids from Central America that also thrive in his alkaline geothermal water. He stocks no more than three species per pond to prevent interbreeding. Minnow traps are used to catch the bulk of the two-inch fish he sells, while a seine is used to catch larger fish and brood stock. Barnes and assistant Pete Booth perform all necessary chores at the year-round breeding and growing facilities.

The State of Oregon regulates Barnes' fish farm like any other agricultural operation. "To protect indigenous fish populations, the fish and game department does not allow me to raise any species of fish not native to the area that might survive if released into the wild," he explains. Obviously, tropical fish from Lake Malawi cannot survive the harsh winters of southern Oregon, and Barnes' geothermal water system commingles pond outflows with 200EF water, effectively killing living creature that might escape. The water's final destination is a cooling pond (with no outlet) that is used for stock watering.

Figure 4. Yellow and black bumblebee cichlids.

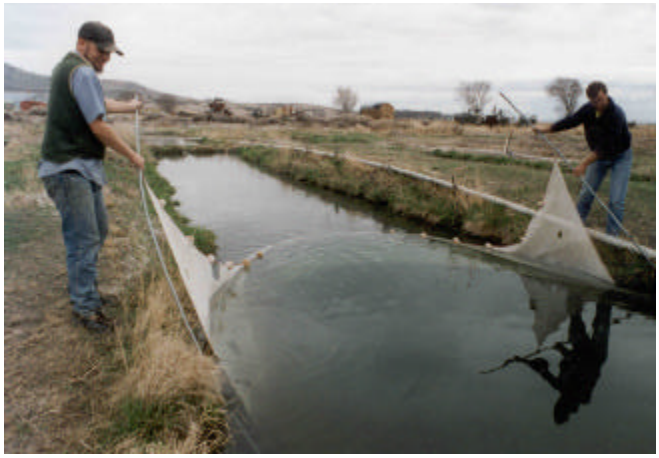

Figure 5. Netting the larger breeding stock (6" to 8") with a two-person seine.

Energy savings garnered by using geothermal water has been the key to Barnes' success in this often difficult business. According to Geo-Heat Center (Oregon Institute of Technology) calculations, at a peak of 300 gallons per minute and a 10E temperature loss from the well to the ponds, Barnes uses approximately 1.5 million Btus of heat energy per hour. Heating his ponds on an annual basis of 6.6 billion Btus (calculated on well use for six months), Barnes avoids the use of two million kilowatt-hours in electricity every year. That's a savings of $100,000 (at current local rate of 5 cents/kWh)!

Barnes' tropical fish farm near Klamath Falls, OR, is a perfect example of cascaded direct use of geothermal waters. With energy savings realized by using this inexpensive source of heated water, and his choice of raising high-value tropical fish, he has successfully met the marketplace. Barnes cost-effectively offers 250,000 Malawi cichlids (3" to 4") per year to tropical fish wholesalers from Portland, OR, to San Francisco, and beyond by truck and air freight.

As Barnes looks out over his operation, he sees the future. "To better utilize the geothermal resource on the property," he says, "we plan to drill an additional well this summer to expand our operations." Developed under a multi-agency Oregon government grant, the well will employ a heat exchanger loop to reheat water from his existing ponds, which will then flow to large fiberglass tanks for raising tilapia, another variety of African cichlid. Barnes will offer this popular food fish as "meat for market," dressed and frozen on site for shipment to wholesalers and restaurants.

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