Faster, better, cheaper: Transgenic Salmon

How the Endangered Species Act applies to genetically modified salmon

History of Genetic Modification

- Genetic modification involves the insertion or deletion of genes and was first performed with bacteria in 1973.
- The 1990s brought about the first approvals for commercial-scale genetic modification of plants.
- If approved by the FDA, genetically modified salmon would be the first commercially available animals for food.

AquAdvantage Salmon

- Transgenic salmon consist of DNA from both the Pacific Chinook salmon and an eel-like fish, called the Ocean Pout, which allows it to keep pumping out growth hormone year-round.
- Natural salmon do not produce growth hormone in the cold, winter weather, and can take up to 7 years (although usually 3 years) to reach reproductive age.
- With year-round growth hormone, the modified fish reach full size in less than half the time, making it cheaper and more efficient for fish farms.

AquAdvantage® Salmon

Size comparison of an AquAdvantage® Salmon (background) vs. a non-transgenic Atlantic salmon sibling (foreground) of the same age.
CREDIT: AquaBounty Technologies

One study found…

- **A number of these transgenic fish showed dramatic increases in their growth rate.**
- **At one year old, the average increase of the transgenic fish was 2 to 6 fold and the largest transgenic fish was 13 times that of the average non-transgenic control.**

Nature Biotechnology **10**, 176 - 181 (1992)

Some seriously modified "other white meat"

- "Given the demand for salmon, it is no surprise that a Frankenfish has emerged — a lab-created hybrid that could soon become the first genetically engineered animal approved by the Food and Drug Administration for human consumption. The company behind these manufactured fish promises that they will not affect ones from an ancient and wild gene pool." – New York Times commentator

Release of transgenic salmon would threatened wild salmon

- The aggressive fish would create **competition** over food and habitat for the wild salmon and could potentially outcompete the fish.
- "**Crossbreeding** between wild stocks and escaped domestic strains of fish could weaken the genetic robustness of wild populations as well as reducing genetic diversity over the longer term."
- **Transmission** of disease
- Introduction of **a new predator** for the wild salmon

Opponent says…

- “The danger is, if the fish gets out, it's a lot more aggressive. It feeds more. It could outcompete not only salmon, but any other local native fish that are in there, because these engineered fish, they actually, not only feed more, but they search in many different places more than the regular salmon. So, that could have an impact.”

Michael Hansen, senior scientist at Consumers Union

The threats include…

- (a) interbreeding with wild salmon, gene introgression, and hybridization with brown trout
- (b) disturbance of habitat or displacement of wild stocks as a result of completion for resources, predation, or even cross-mating resulting in population impact
- (c) spread of bacteria, viruses, parasites to wild salmon and other aquatic/estuarine species
- (d) ecological impacts associated with their degree of fitness, interaction with other organisms, role in ecological processes, and potential for dispersal and persistence.

Endangered Species Act

- Section 9 of the Endangered Species Act ("ESA") specifically prohibits the "take" of an endangered species. "Take" is broadly defined to include harassing, harming, pursuing, wounding or killing such species. The term "harm" is further defined to include "significant habitat modification or degradation where it … injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering." The ESA's legislative history supports "the broadest possible" reading of "take." "Take" includes direct as well as indirect harm and need not be purposeful.

- Harm may occur through significant habitat modification that actually kills or injures a protected species by impairing essential behavior patterns, including breeding, feeding or sheltering.

Release of farmed fish threatens wild populations

- hundreds of thousands of farmed salmon escape into the wild every year
- the potential for genetically modified salmon to enter the wild is just as high – only the damage would be even greater
- the genetically modified fish not only feed more than natural salmon but grow at twice the rate, and they have been noted for their unusually aggressive behavior

- “Since 1985, roughly one million Atlantic salmon have escaped in the Pacific Northwest and established breeding populations. A single storm in Maine in December, 2000, led to the escape of 100,000 salmon.”

Traditional Sea Pen Fish Farms

Decline of the wild Chinook Salmon

- Nine populations of Chinook salmon are listed as either threatened or endangered under the Endangered Species Act, and under the policy of the National Marine Fisheries Service, each distinct population segment is treated as a separate species.

- Factors leading to the decline in wild salmon include water diversion and habitat loss. Studies indicate that in most western states, about 80 to 90% of the historic riparian habitat has been eliminated due to water diversions for agriculture, flood control, domestic, and hydropower purposes. [NMFS, 1998 Report]

Wild Chinook Salmon

The carcass of a wild Chinook salmon after spawning upstream

The law…

- Dealing with the issue of genetically modified fish puts governmental agencies in unchartered territory, as current laws do not apply with adequate specificity.
- But given what we know about the dangers of introducing new species of fish and plants into unnatural ecosystems, the burden of proof should be on the entity seeking approval to develop genetically modified organisms.

Only one facility has provided an environmental assessment

- Prior to FDA approval, the AquAdvantage was required to undergo an Environmental Assessment (EA).

The AquAdvantage® Technique

- All females
- Sterile
- Inland tanks; physical barriers between tanks and open waters
- Lack of ability to survive in wild; altered feeding habits

Opponents argue…

- AquaBounty has conceded that up to five percent of the salmon eggs produced from genetically modified salmon could be fertile.

Safer Inland Tanks

Safer ocean farms

Environmental benefits of GM Salmon

- Could reduce the strain of fishing on the natural salmon populations
- Health benefits of eating salmon: reduction of heart attacks

Conclusion

- “There are several unknowns and uncertainties regarding possible genetic, ecological, and environmental effects of AquAdvantage salmon that must be elucidated before an environmental risk assessment can be thoroughly evaluated and approved. This, along with a situation where regulatory oversight is adequate at best, suggests that approval of Aqua Bounty Technologies’ request for commercial rearing of AquAdvantage salmon is premature.”

U.S. Fish and Wildlife Service Conservation Genetics Community of Practice letter to U.S. FDA. October 6, 2010.