



FILED UNDER: [ANIMAL ANATOMY AND PHYSIOLOGY](#) | [ANIMAL BEHAVIOR](#) | [ENVIRONMENTAL BIOLOGY](#) | [FISH, MOLLUSKS AND CRUSTACEANS](#) | [MARINE BIOLOGY](#) | [RESEARCH METHODS \(BIOLOGY\)](#)

Trout Go with the Flow (Sometimes)

by Patricia Waldron | August 2020

 Print  Download  Share  Save  Read Aloud [Glossary Links: ON](#)

One of the secrets to a productive [fishing](#) trip is picking just the right spot to cast your fishing line. Ask experienced fly fishers and they'll probably tell you that the fish will be biting in the choppy parts of the river, and not the areas with a smoother flow. Their reasoning is that fish will choose parts of the river where rocks and logs break up the current, giving them places to hide out and rest while waiting for food to float their way. In the smoother parts of the river, fish have to constantly swim against the current while trying to get a bite to eat.



GarysFRP/Stock/Getty Image

Recently, researchers from the University of Florida in Gainesville led a team that monitored rainbow trout as they foraged for food inside a simulated stream environment in the lab.

To find out if the anglers' advice was spot on, or just a big fish tale, James Liao, from the [University of Florida](#) in Gainesville, led a team that monitored [rainbow trout](#) as they foraged for food inside a simulated stream environment in the lab. They discovered that when the [current](#) is slow, fish can save their strength by taking refuge behind a barrier and emerging only to snatch at [prey](#). But as the speed of the water increases, it takes more and more [energy](#) to fight the current as they lunge out from their refuge, and they're less likely to successfully snag a meal. Using [computer modeling](#), Liao and his team concluded that fish can be most energy efficient by resting behind rocks for half the day, and then hunting in smoother currents the rest of the time. The new study appears in the [Journal of Experimental Biology](#).

Related Content

[Two Meals for the Price of One](#)

Nudibranchs are sea slugs known for their psychedelic colors, ranging from neon orange to fluorescent purple, and for their intense patterns, featuring stripes...

[Stealth Mode: How Cuttlefish Evade Prey](#)

Predation is a constant of nature. All animals have to eat, but nobody wants to become somebody else's meal. Prey species employ many different methods to...

[Leadership Lessons in Fish School](#)

In the United States, election season is around the corner, and many Americans wonder which of the many presidential candidates has the greatest leadership...

[Prey Find Safety in Numbers](#)

A school of fish or a swarm of plankton might seem to offer a big, appealing target to a predator, but being part of a group actually improves a potential...

[Fish and Rice Grow Well Together](#)

The need to keep out harmful species makes farmers spend billions of dollars on pesticides every year. There are forms of agriculture, though, where other...

"We tested the long-standing hypothesis that foraging fish expend less energy when refuging compared with swimming in the freestream," the researchers write. "By directly measuring oxygen costs of foraging fish, we demonstrate that fish foraging in fast flow do not gain an energetic benefit when refuging."

Are Refuges a Red Herring?

Liao's fascination with fish got an early start. As a child he fished with his parents in Prospect Park in Brooklyn, New York and avidly consumed fly-fishing magazines. When Liao was a graduate student, he discovered that rainbow trout take advantage of turbulent water by bouncing off of eddies, which help propel them forward. In his current research, he studies how fish sense turbulence and changes in water flow and respond by altering their swimming behavior.

To find out whether hiding behind rocks was a good strategy for foraging fish, Liao and his lab members investigated how much energy rainbow trout use under different conditions. They tested the trout using a large tank of circulating water, which functioned like a treadmill for fish. The researchers could dial up or down the speed of the flowing water and add or remove barriers to create refuges.



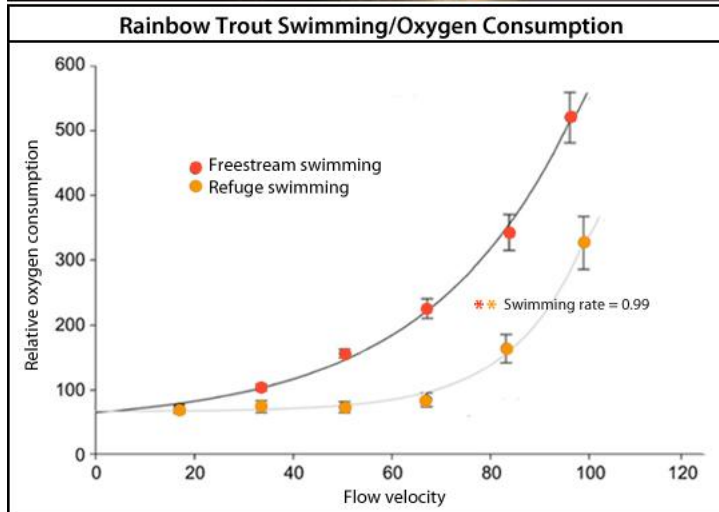
Shutterstock

The researchers tested the long-standing hypothesis that foraging fish expend less energy when refuging compared with swimming in the freestream. They chose the rainbow trout (*Oncorhynchus mykiss*), a common fish species that lives in streams along the West Coast of North America and in the Kamchatka Peninsula in Asia.

The researchers chose the rainbow trout (*Oncorhynchus mykiss*), a common fish species that lives in streams along the West Coast of North America and in the Kamchatka Peninsula in Asia. Fishermen have also introduced the fish to lakes and streams across the U.S. and in other countries. Rainbow trout are drift feeders, meaning that they snag whatever morsels of food drift along in the current. They aren't picky and will eat aquatic insects, fish eggs, bits of dead things, small fish, crustaceans and land insects that have fallen into the water. Typically, rainbow trout prefer hunting in faster currents than slower ones, because they deliver food at a faster rate.

No Rest for Weary Rainbow Trout

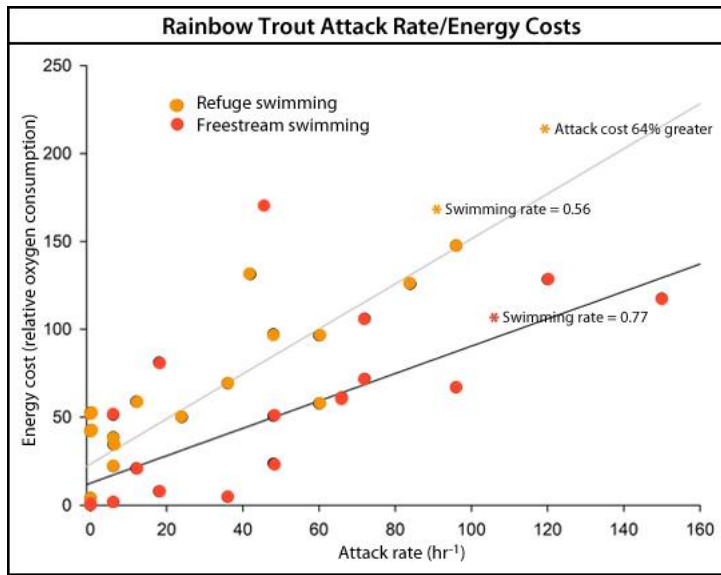
First, the researchers placed rainbow trout, one at a time, into a tank and measured how much oxygen they used as they swam at different speeds. Fish use oxygen to break down food and produce energy, so the researchers were able to estimate how much energy the trout burned as they swam, based on how much oxygen they took up from the water. The speed of the current ranged from almost nothing to about 2.2 miles per hour. As expected, the trout burned more energy when the speed of the current in the tank increased.



Top: James Gritz/Photodisc/Getty Images; Bottom: Johansen, J. L., et al./Journal of Experimental Biology/M. Bank

The researchers placed rainbow trout, one at a time, into a tank and measured how much oxygen they used as they swam at different speeds. Fish use oxygen to break down food and produce energy, so the researchers were able to estimate how much energy the trout burned as they swam, based on how much oxygen they took up from the water. As expected, the trout burned more energy when the speed of the current in the tank increased.

Next, the researchers tested how much energy the trout used as they hunted. In some trials, trout swam in the open freestream as they waited for food to come along, and in others the trout had a barrier that blocked the flow of the water offered a refuge. After tricking the trout by releasing food-scented water into the tank to get its attention, the researchers dangled a fishing line attached to a tiny bite of fake food. Once the trout lunged, the researchers would yank away the string. "They would sometimes chase it upstream," said Liao in an article published alongside the paper. By measuring oxygen consumption, the researchers could see which hunting style—hiding and lunging, or swimming in the freestream against the current—used the most energy.

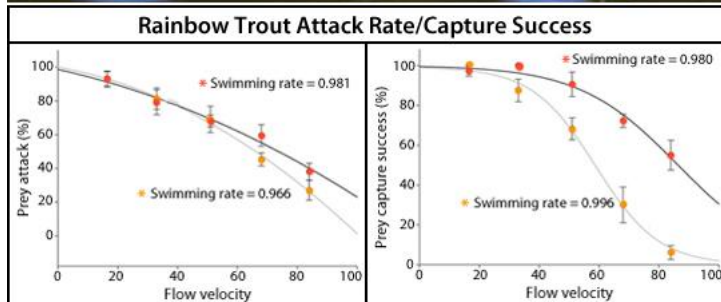


Johansen, J. L., et al. *Journal of Experimental Biology*/M. Bank

The researchers also tested how much energy the trout used as they hunted. In some trials, they swam in the open freestream as they waited for food to come along, and in others they had a barrier that blocked the flow of the water offered a refuge. When the trout had a barrier to hide behind, they could conserve their strength at slower current speeds. But as the water speed increased, the refuge stopped being an advantage and started to hinder the trout's performance.

When the trout had a barrier to hide behind, they could conserve their strength at slower current speeds. But as the water speed increased, the refuge stopped being an advantage and started to hinder the trout's performance. At higher water speeds, it took increasing amounts of energy for the trout to throw themselves into the current when it was time to attack. Refuging trout used 64% more energy while foraging for food compared to trout that simply swam in the freestream flow without a barrier.

"Energy needed to accelerate from a place of refuge into faster freestream flow necessitates traversing across a steep velocity gradient," the researchers write. "Compared with foraging in freestream flows, refuging fish that dart out to capture food are expected to accelerate more quickly in order to overcome these velocity gradients."



Top: Thomas McGuane/Cornell University; Bottom: Johansen, J. L., et al. *Journal of Experimental Biology*/M. Bank

The researchers found that trout that attacked the food from behind the barrier were 40% less successful at grabbing their prey. Combined with the extra energy needed to emerge from the

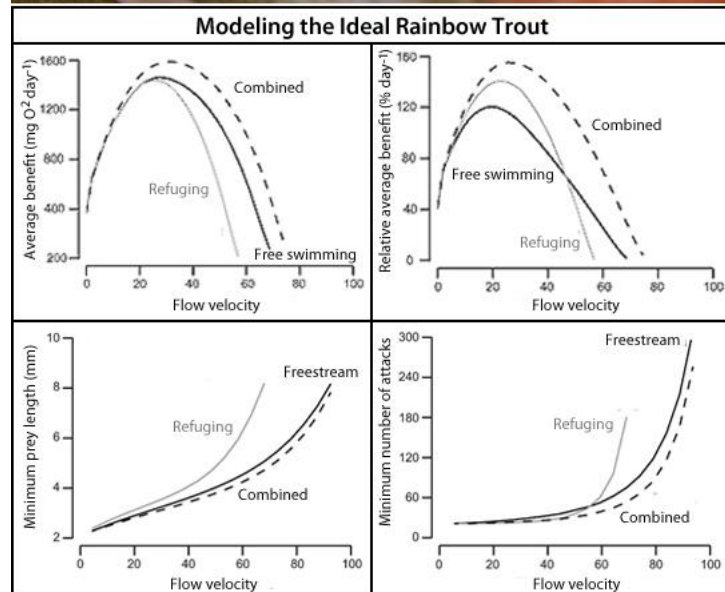
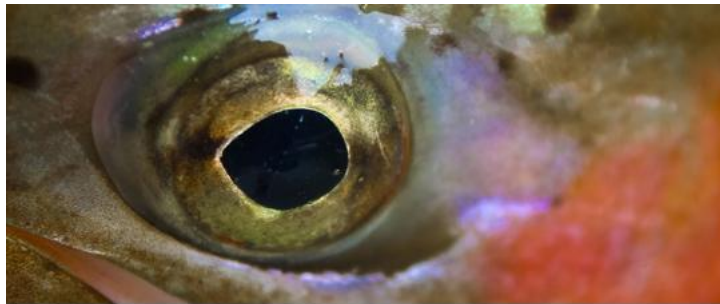
refuge, hunting from behind a barrier becomes a losing strategy for the trout in waters that are moving more swiftly.

Faster currents bring more food, but they also make it harder to catch the prey, so the researchers tested the trout's success rate when trying to grab an approaching food pellet. As the current speed increased, trout had a harder time intercepting the pellet regardless of which strategy they employed, but trout swimming in the freestream had better odds of grabbing lunch. Trout that attacked the food from behind the barrier were 40% less successful at grabbing their prey. Combined with the extra energy needed to emerge from the refuge, hunting from behind a barrier becomes a losing strategy for the trout in waters that are moving more swiftly.

Modeling the Ideal Fish

At top current speeds, none of the trout were able to catch any food, regardless of their foraging tactics. This finding suggests that people fishing in smooth, fast waters are unlikely to catch anything. One caveat, which the researchers point out, is that these findings only apply to bits of food that are passively floating down a river. It's possible that in slower currents, insects and other live prey might be able to wriggle away from fish, which may make it harder for them to forage in slow-moving parts of a stream.

Using data from their experiments, the researchers created a computer model to estimate how much energy trout would use under different conditions. At low current speeds, around half a mile per hour or less, both foraging strategies were equally effective. But as water speed increased, trout could save energy by ditching the refuges and foraging within the freestream. "Our model predicts that individuals living in flows greater than [1.12 miles per hour] should avoid refuges while foraging," said Otar Akanyeti, a former member of Liao's, in an accompanying news article.



Top: Shutterstock; Bottom: Johansen, J. L., et al./Journal of Experimental Biology/M. Bank

Using computer modeling, the researchers concluded that the most energy-efficient way for trout to spend their time is to feed while swimming in the flow of the stream for 12 hours each day and to spend the rest of their time hiding out in a refuge, saving their strength.

Overall, the model predicted that the most energy-efficient way for trout to spend their time is to feed while swimming in the flow of the stream for 12 hours each day and to spend the rest of their time hiding out in a refuge, saving their strength. Liao, however, suspects that fish are using other energy-saving tricks that we don't yet know about.

The extra energy needed to attack from a refuge in faster waters means that fish who use this strategy will need more food to support themselves. This could limit where trout are able to survive within a stream ecosystem, based on their foraging strategy. "Our experimental results provide a framework to understand the mechanisms underlying habitat preferences and movement patterns in current-swept environments," the researchers write. Now, stream ecologists can test these findings in the wild, to see if rainbow trout are living and foraging in the same way that Liao and his colleagues predict. The study's findings may also be useful for river restoration, so that ecologists can recreate environments preferred by trout and other fish.

Finally, the study suggests that anglers may be overestimating the benefit of refuges for trout. So, next time you grab your fishing pole and head out to a stream, if the choppy waters aren't yielding any fish, try casting your line in the open freestream instead.

Discussion Questions

What are other factors that could affect where rainbow trout chose to rest or forage in a river?

Suppose that refuges allowed trout to sneak up on larger prey. If that were true, how might that affect the researchers' conclusions?

How would you design an experiment to find out what types of environments rainbow trout use to hunt and rest in the wild?

Journal Abstracts and Articles

(Researchers' own descriptions of their work, summary or full-text, on scientific journal websites.)

Johansen, J. L., Akanyeti, O. and Liao, J. C. "Oxygen consumption of drift-feeding rainbow trout: the energetic tradeoff between locomotion and feeding in flow." *Journal of Experimental Biology* (June 26, 2020) [accessed July 10, 2020]: <https://jeb.biologists.org/content/223/12/jeb220962>.

Bibliography

Gudrais, Elizabeth. "The Way of Trout." *Harvard Magazine* (March-April 2004) [accessed July 10, 2020]: <https://www.harvardmagazine.com/2004/03/the-way-of-trout.html>.

Johansen, J. L., Akanyeti, O. and Liao, J. C. "Oxygen consumption of drift-feeding rainbow trout: the energetic tradeoff between locomotion and

feeding in flow." *Journal of Experimental Biology* (June 26, 2020) [accessed July 10, 2020]: <https://jeb.biologists.org/content/223/12/jeb220962>.

Knight, Kathryn. "Surfing behind rocks costs trout dear when feeding." *Journal of Experimental Biology* (June 26, 2020) [accessed July 10, 2020]: <https://jeb.biologists.org/content/223/12/jeb230086>.

Keywords

rainbow trout, *Oncorhynchus mykiss*, prey capture, drift feeding, foraging, refuge, energy, locomotion, J. L. Johansen, Otar Akanyeti, James Liao

Citation Information MLA APA Chicago Manual of Style

Waldron, Patricia. "Trout Go with the Flow (Sometimes)." *Today's Science*, Infobase, Aug. 2020, <https://tsof.infobaselearning.com/recordurl.aspx?wid=10835&ID=44965>. Accessed 2 Sept. 2020.

 Record URL: <https://tsof.infobaselearning.com/recordurl.aspx?wid=10835&ID=44965>



Sources
Terms of Use
Privacy Policy
About this Database
About Infobase
Contact Us

All Topics Page
Conversations with Scientists
Crossword Puzzles
Editorial Cartoons & Questions
Video News Briefs
Glossary

Curriculum Tools
Research Topics
Help
How to Cite

→More Infobase Resources

Copyright © 2020 Infobase. All Rights Reserved.

Select Language  Powered by  Google Translate