



The Science of Felt

In September 2008, Trout Unlimited called on all wader manufacturers to eliminate the use of felt soles on their boots by 2011. Just a week later, Simms Fishing Products introduced a new line of felt-free boots and announced that, beginning in 2010, they would no longer sell wading boots with felt soles. These actions came about as a result of increasing concerns that felts soles were providing a perfect home for invasive species. In fact, New Zealand had already announced that they were banning the use of felt soled boots beginning October 1, 2008. Since that time there have been additional felt bans enacted (SE Alaska beginning January 1, 2011) and most wader companies have included felt free alternatives in their product line.

The response from the fishing community to these actions has been mixed. Many anglers are embracing the new boots and believe that if protecting our waters means giving up felt they are fine with the trade. However, others are not so accepting. There are a number of common reasons that anglers do not want to switch including cost and the belief that the new waders do not work well in certain types of water. Recently, some have been questioning the science that underlies the movement to eliminate felt. They argue that anglers are being railroaded into buying new boots based on no or flawed science, that there is no proof that anglers are moving invasives and that there is no proof that felt is worse than any other part of a boot.

This is an argument that provides a great excuse to anyone who wants to avoid switching to felt free boots for any reason. Being able to say that there is no science and we are being manipulated is a great story for anyone who does not want to change and we are certainly seeing that happen. However, despite some very persuasive claims, there is sound scientific evidence that felt is a unique problem.

To best understand this issue we need to back up and look at what put the focus on felt in the first place. The single biggest factor was the rapid spread of didymo in New Zealand. Didymo, *Didymosphenia geminata*, is a single celled algae that is causing significant impacts to pristine trout waters worldwide. Originally native to the Northern Latitudes, didymo was not historically a problem in its native waters. However, following its introduction to New Zealand in the early 2000's it quickly became a significant ecological and economic problem.

In 2006, The Federation of Fly Fishers hosted an international didymo conference where experts discussed what was known and unknown about this invader. The information presented was comprehensive and resulted in the publication of a didymo white paper that contained the best information available at the time. There was considerable discussion of how didymo was being spread and it was concluded that there could be no doubt that viable didymo cells were being transported by waders but that all parts of a



boot were considered to be part of the problem. At this that time there was no specific research data that could provide better info and written reports included speculation that other parts of the boot might actually be more significant than the felt soles.

Of course, conference attendees realized that additional research was underway that would provide more answers as well as raise new questions. Unfortunately, the papers produced from the conference could only contain the info available at publication and do not contain the latest research results. The claims we hear today that there is no science to justify a felt ban is a result of people studying the results reported at the 2006 conference and not the results of research conducted since then. So, what have we learned since 2006?

Do Anglers Move Didymo

Unless we observe the introduction of an invasive species it is difficult if not impossible to determine how it was first introduced. As Didymo has spread around the world we know when new discoveries are made but lack direct proof of how it got there. Scientists are studying this problem and two recently published studies give us a better grasp of how anglers are likely spreading invasives.

In 2007 at Montana State University, graduate student Kiza Gates published the results of her study of the potential for angler movement of whirling disease (WD) <http://etd.lib.montana.edu/etd/2007/gates/GatesK0507.pdf>. In the course of her research she studied anglers' waders to determine the probability of their transporting WD and discovered that the average angler who does not clean their boots is transporting 16.78 grams (.59oz) of sediment on their waders from one access site to another. Her work showed that the amount of sediment was the same for people arriving at a site and leaving a site which means that anglers are moving sediment between waters.

The next question she looked at was if WD was being carried between sites in this sediment. Unfortunately, the level of technology available did not allow her to answer the question for WD. However, a New Zealand mud snail was discovered in the sediment recovered from one boot which shows that invasive species are definitely being transported in the sediment carried on waders.

Thus, we know that anglers can be transport didymo in this fashion. But, is it being transported this way? Canadian researcher Max Bothwell and his collaborators have examined the spread of Didymo on Vancouver Island to try and determine how the species is spread. Although they do not have actual observations of anglers causing new introductions, they concluded that *“the pattern of didymo spread among rivers on Vancouver Island correlates with the activity of fishermen and the commercial introduction and widespread use of felt-soled waders in the late 1980s”*

They present the complete results of their work in a scholarly article published in *Fisheries* <http://www.env.gov.bc.ca/wat/wq/studies/didymo-blooms.pdf>. In the course of



their research they noted a significant relationship between the presence of Didymo and the presence of anglers. They particularly note rivers in which didymo is not found upstream of angler access points and rivers that are closed to fishing that are surrounded by Didymo but remain free of it. Citing other examples from around the world, they conclude that there can be no doubt that anglers are primarily responsible for spreading Didymo.

Why Focus on Felt?

With overwhelming evidence that fishing boots are spreading invasives the attention has turned to how to minimize the risk that anglers are transporting Didymo. Research has shown that there are some practical options for killing Didymo on fishing equipment <http://www.biosecurity.govt.nz/files/pests/didymo/didymo-decon-feb-05-rev-aug-06.pdf>. Heat, cold, drying and exposure to chemicals are all effective at killing the algae so the issue becomes, how does an average angler achieve the lethal levels for any of these methods?

When researchers looked at this question it became obvious that felt presented disinfection problems that other materials did not. The main reason for this is the nature of the felt material. Felt is constructed as a dense mat of randomly woven fibers. It has large interstitial spaces that can be a perfect trap for any small materials. Gates, in the study referenced above, did extensive work to determine the relative ability of various wader materials to trap WD spores. In her experiments, felt trapped 100% of the WD spores that it was exposed to while rubber trapped none. This is dramatic evidence that felt soles present a much greater risk of transport than rubber soles.

However, as already noted, there are effective methods for killing Didymo and it is logical to assume that felt can be disinfected using these techniques. Unfortunately, research from New Zealand shows that disinfecting felt soles is much more difficult than might be expected. Quite simply, the nature of the felt material is such that live Didymo cells could easily penetrate the interior layers of the felt soles but treatment methods for killing Didymo are ineffective at disinfecting these inner layers of felt. Thus, even after following recommended decontamination procedures, it was possible that felt soled boots were still spreading Didymo.

In their paper titled *Studies on the survivability of the invasive diatom Didymosphenia geminata under a range of environmental and chemical conditions*, <http://www.biosecurity.govt.nz/files/pests/didymo/didymo-survival-dec-06-rev-may-07.pdf> the researchers fully document the experiments they conducted. In their experiments felt soled boots that were examined at 5 hours after use in infested waters contained nearly 3,000 times more live Didymo cells than rubber soles (11,000 vs. 3.9). At 36 hours, a second careful cleaning yielded significant numbers of live cells from the felt soles and no live or dead cells from the rubber soles (290 vs. 0). We should note here that both leather shoe uppers and neoprene materials also held live cells at 36 hours but at much lower levels than the felt.



Careful experiments were then conducted to judge the efficacy of the various treatments for killing all of the live cells that might be trapped on waders. The results showed that most of the recommended treatments were effective at killing all of the cells found on most parts of the boot but that felt soles were an exception and it was difficult to achieve a complete kill of didymo trapped in felt soles. Specifically, the authors concluded:

- Felt soles present a greater risk of transfer than the other materials tested.
- Soaking in a disinfectant solution is far more effective than spraying (spraying was deemed to be totally ineffective)
- Even after 20 minutes of soaking the disinfectant does not full penetrate all areas of the felt sole
- Complete drying of felt soles is very difficult – soles can remain damp for weeks
- Heating the boots to 45°C (113°F) for at least 20 minutes will disinfect the soles

Based on the results of this research New Zealand determined that felt represents a unique threat that could only be adequately addressed through a complete ban. That ban is now in place and all New Zealand anglers are now felt free. With an Alaskan felt ban already approved and other US felt bans being considered we can expect that the move to eliminate felt will grow quickly.

What Does This Mean for Anglers

There is scientific proof that felt represents a special problem in wading boots. Although many boot parts are capable of trapping and carrying AIS, the difficulties of disinfecting felt make it very different from the rest of the boot parts. While the elimination of any boot part that could trap or transport AIS is beneficial, the move to eliminate felt is a prudent and responsible response to the threat it poses.

We need to recognize that much of the motivation for eliminating felt is focused on didymo. An argument can be made that felt only matters when the invasive species is microscopic and that any larger invader will be on the surface of the felt where it can be removed or killed. In fact, this is true. If the organisms are on the surface of the felt they can be eliminated. However, didymo is only one of our microscopic invaders. It has already been demonstrated that felt can easily trap and transport whirling disease spores and we must be realistic and recognize that there are likely new microscopic invaders still to come. Thus, it is only prudent that we move away from felt.

The debate over the effectiveness of rubber soles verses felt will continue to rage and there is no doubt that some anglers will insist that their recreational desires should take precedence over the resource issue. However, the move to eliminate felt is based on conclusive scientific proof that it represents a special threat. Companies, organizations and agencies are all accepting of this and the move away from felt will continue to grow. Anglers may not like the change and some will be vocal in their opposition. However, we should all make sure that any argument is based on sound science. The science shows that felt is a special problem and anyone disputing that has nothing to back their claims.



Finally, we must realize that felt is only one part of the problem. As already mentioned, there are many other places where invasives can be trapped and transported in our boots and other gear. We must adopt new habits that include careful cleaning after each use. While switching to felt free waders is a good thing, it is just on step in the process of becoming a clean angler. Any one of us could be the person to carry an invader to a new water and none of us wants to be that person. Inspect, Clean and Dry your gear after each use and you will help to protect the resource that we all depend upon.

The Invasive Species Action Network (ISAN) is dedicated to reducing the human caused spread of aquatic invasive species. ISAN is responsible for the Clean Angling Pledge and other programs that engage anglers in active efforts to protect our resources. ISAN is a 501c3 non-profit organization based in Livingston, MT. For more information visit www.cleanangling.org.

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