Fish Health Center

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Summer 2023 Highlights:

Even with the pause in our fish health inspection season, the Bozeman FHC has been operating at full steam this summer! Along with a constant flow of samples from our partners, we continue implementing the rollout of the new Aquatic Animal Health Policy.

Laboratory Services Supporting Federal Recovery, Restoration and Recreation – Summer 2023:

- Led by Lacey, the BFHC co-hosted the annual fish health biologists meeting with the D.C. Booth Historic National Fish Hatchery in Spearfish, SD (6/12-6/16). A range of fish health topics and cases were covered. We also discussed expanding the collaboration between our hatcheries, health centers, and technology centers. Representatives from FHCs, FTCs, FWCOs, and hatcheries were present.

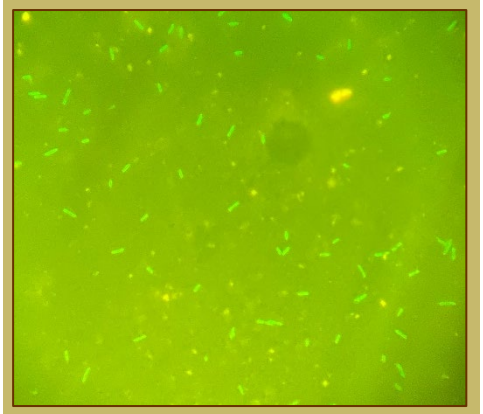
- We continue to work towards the implementation of the new FWS National Aquatic Animal Health Policy. The biggest step has been writing Health Management Plans for each of the hatcheries in region 6. This is a joint effort between the BFHC, federal hatcheries, and the regional headquarters.

- Since mid-May, we have completed the following for federal hatcheries and wild waters in federal jurisdiction: two complete inspections, ten virology inspections, one bacteriology case, and two PCR-only cases. There were 10 troubleshooting cases that required sample collection for lab diagnostics.

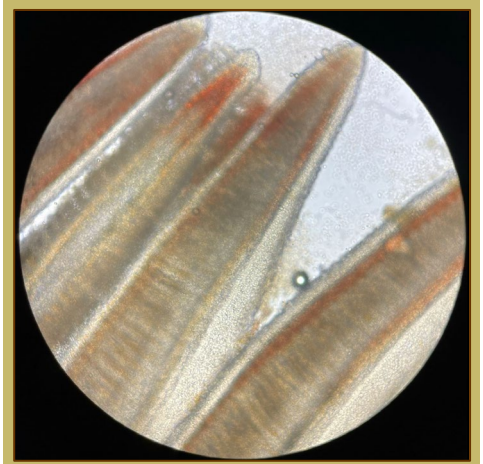
- Rick spent a week in the Rocky Mountains National Park backcountry collecting water samples for eDNA testing and wild fish samples for complete inspection. This is an annual joint effort with Chris Kennedy from the USFWS Colorado FWCO.

Upper left: Chris Kennedy, Rick's RMNP sampling partner-in-crime. Photo: USFWS/R. Cordes.
Upper right: Annual fish health biologists meeting. Photo: USFWS/D.C. Booth Historic National Fish Hatchery.
Bottom left: Razorback sucker from Ouray NFH. Photo: USFWS/J. Veilleux.

Juvenile cutthroat trout with clinical symptoms consistent with bacterial coldwater disease caused by *F. psychrophilum*. Photo: USFWS/A. Bode.



Direct fluorescent antibody test (DFAT) showing *Flavobacterium psychrophilum* cells from a cutthroat trout. This is the causative agent of bacterial coldwater disease. Photo: USFWS/J. Veilleux.



Wet mount showing gill filaments of a razorback sucker. These are unhealthy gills, as there is an almost complete loss of lamellar structure. Lamellae are the primary gas-exchanging unit of the gill. Photo: USFWS/J. Veilleux.

Laboratory Diagnostic Support to Reduce Hatchery and Wild Fish Losses:

- Staff participated in numerous phone calls, email conversations, and site visits with hatchery managers and partners regarding fish health issues, infrastructure and biosecurity questions, and treatment recommendations. This included:
  - Nutritional concerns: feeding frequencies and diet types across different species, amphibian vitamin supplementation, etc.
  - Water quality problems: environmental gill disease, algal blooms, biosecurity concerns, etc.
  - Pathogens: *Ichthyobodo* spp., *Aeromonas salmonicida*, *Flavobacterium psychrophilum*, and more.

- Provided veterinary support to the Wyoming Toad colony at Saratoga NFH and a Mississippi map turtle at Garrison Dam NFH.

- As part of his contracted veterinary duties, Jake worked with a partner program in vaccinating over 50,000 rainbow trout against *Aeromonas salmonicida*.

Laboratory Services Supporting Partner Recovery, Restoration and Recreation:

- Montana Fish, Wildlife and Parks: from tissue samples submitted to the lab, staff conducted nineteen hatchery and wild fish complete inspections, four bacteriology cases, sixteen virology cases, seven histology-prep cases, and one PCR confirmation case. This included multiple submissions involving wild waters experiencing fish morbidity and mortality events.

- Kansas Wildlife and Parks Commission: from samples submitted to the lab, staff completed one virology inspection and one eDNA analysis.

- Private: One virology troubleshooting case for sturgeon from an aquarium, one virology inspection of an aquaculture facility in Kansas, and one complete inspection of a cutthroat trout aquaculture facility.

- Lacey, Rick, and Renee continue to work on an eDNA project involving validating a PCR for Alligator Snapping Turtles. This work is a collaborative effort between USGS and Air Force partners.

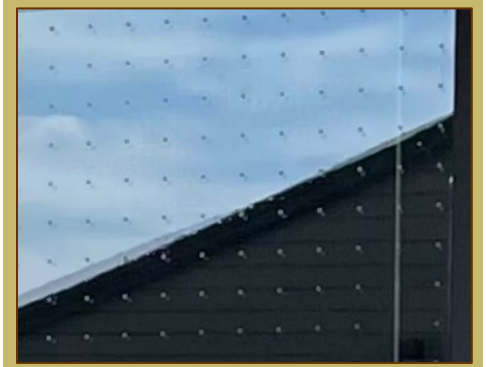
- Molly completed 28 virology cases, the brunt of the caseload coming from Montana FWP and our federal hatcheries. Each virology case takes at least 28 days to finish!

- Tammy processed slides from eleven different cases this summer! These were submitted by federal and state partners, representing a plethora of fish species.

- Jake continues to work closely with Montana FWP. Since beginning a veterinarian-client-patient-relationship with them, he's visited eight FWP hatcheries and signed numerous Veterinary Feed Directives adhering to judicious antimicrobial usage.

Just one part of the amazing pollinator garden at the BFHC, filled with a careful selection of native and nonnative plants. Photo: USFWS/J. Veilleux.

A bee box adjacent to our pollinator garden. Photo: USFWS/T. Weiss.



Close-up photograph of a BFHC office window with bird strike film installed. Stickers are 2-inches apart. Photo: USFWS/T. Weiss.

Outreach and Education:

- The Bozeman FHC pollinator garden has returned thanks to Tammy's two green thumbs. Consisting of mixed native and nonnative plants, the garden attracts pollinators like bees, wasps, moths, butterflies, and hummingbirds. Other non-pollinator species such as rabbits, birds, and spiders also enjoy the garden!

- Tammy and Lacey worked hard to make our office more bird friendly. In September, bird strike window film was applied to several office windows and doors to mitigate future bird collisions.

- Spearheaded by Renee and Tammy, the BFHC has participated in the 100 Days of Summer Safety Campaign. Topics were Safety Slogans, Safety Walk for Wellness, Local Conditions, Canine First Aid and CPR (given by Jake), Active Shooter and Threat Training, and Safety Pledge and Bird Collisions. BFTC and AADAP colleagues joined several of these events.

- Lacey led several visitor tours of the BFHC this summer, showcasing all that we do to members of other federal agencies and the public.

Partnerships, Employee Development & Other News:

- Rick has been hard at work in preparing the BFHC's application for the AFS-FHS Quality Assurance Tier 2 program. This is part of a multi-tiered program for quality assurance and quality control in aquatic animal laboratories. It has been a time intensive, but important task.

- Jake attended AQUAVET II - Comparative Pathology of Aquatic Animals at Roger Williams University in Bristol, Rhode Island.

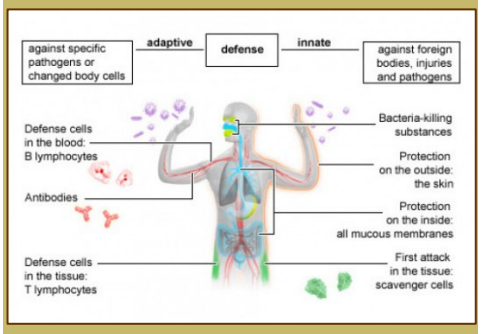
A collection of various pollinating species that have visited our flower beds this summer. Photos: USFWS/T. Weiss.

Fish Health 101: Vaccination

What's this?

Each newsletter will have an installment of **Fish Health 101**. It will briefly cover a topic of fish health you may find of interest.

In this edition, we'll talk about the basics of fish vaccination. Vaccination is a complicated topic, so this section is not meant to be a full explanation, but a broad overview. If you have further questions or would like to request a topic, email Jacob_Veilleux@fws.gov



Adaptive versus innate immune system (InformedHealth.org, 2006). Available from: https://www.ncbi.nlm.nih.gov/books/NBK279396/

*This information is true for teleosts (ray-finned fish). Other infraclasses within Actinopterygii have notable differences. Some may have cephalic, heart, gonad, and/or GI involvement in immune system development, in addition to or in lieu of the thymus, spleen, and kidney. There are several other tissues not listed here.

Bottle of *A. salmonicida* bacterin to be used as an immersion bath. Vaccine was diluted 1-part bacterin to 4-parts water. Photo: USFWS/J. Veilleux.

1. Vaccines and the Immune System

- **How does a fish's immune system compare to that of a mammal?** Like other vertebrates, fish have an innate and adaptive immune system.
  - Innate immune system: A non-specific response that can respond quickly to assault. This includes many different mechanisms such as physical and chemical barriers, white blood cells (like neutrophils and macrophages), cytokines, and the complement cascade.
  - Adaptive immune system: Specialized to a specific pathogen but takes time to form a response during the first encounter. After that, the body has a blueprint for fighting future infections.
    - Components include but are not limited to:
      - B cells: White blood cells that produce antibodies.
      - Antibodies: Proteins that recognize and bind to a specific pathogen's antigen. An antigen is a marker that the body recognizes as harmful.
      - T cells: White blood cells that can kill virus-infected and cancer cells, activate other B and T cells, and much more.
  - In addition to the innate and adaptive immune system, there is also humoral and cell-mediated immunity to consider. We'll focus on how these mechanisms fit into the adaptive immune system.
    - Humoral immunity (antibody-mediated): antigens are presented to a B-cell, which then secretes antibodies that will recognize and bind to other antigens. Once bound, they can be presented for further recognition or destroyed by other immune cells.
    - Cell-mediated immunity: Cells with foreign antigen on their surface can be destroyed by T-killer cells and other white cells. This happens to virus-infected, intracellular bacteria-infected, and cancer cells.
  - Organs involved in immune system development: primarily the thymus, anterior kidney, and spleen*
- **What is a vaccine?** A substance containing killed, weakened, or fragmented pathogen that stimulates the immune system without causing disease.
- **What types of vaccines are there?**
  - Three of the more common types of vaccines in the fish world are:
    - Inactivated: Made from inactivated or killed pathogen. This class of vaccines stimulates primarily humoral immunity (antibody-mediated immunity) and may require further boosters for full protection.
      - A bacterin is a vaccine made from killed bacteria.
    - Sub-unit: Made from pieces of a pathogen such as a protein. This stimulates an antibody-mediated immunity.
    - Live, attenuated vaccines: live pathogen that have been weakened and can no longer cause significant disease. They produce a strong, lasting immunity by stimulating cell-mediated and humoral responses.
  - Other types of vaccination in aquaculture are DNA and recombinant vaccines.
  - Within those categories, there are also autogenous vaccines and licensed, commercial vaccines:
    - Autogenous: made from pathogen isolated from the facility. These are restricted to use by or under the direction of a licensed veterinarian.
    - Licensed, commercial: produced by a manufacturer for a specific disease and fish species. They are licensed by USDA-APHIS and undergo testing for safety and effectiveness.

Injecting vaccine into the coelomic cavity of an adult rainbow trout. Photo: K. Onofryton.

Immersion *A. salmonicida* vaccination in juvenile rainbow trout. Trout were submerged in the solution for 60 seconds to ensure the correct dosage was achieved. Photo: USFWS/J. Veilleux.

Clinical manifestation of furunculosis caused by *A. salmonicida* in rainbow trout. Photo: MFWP/J. Nachtmann.

- **Why do we need to know so much about the immune system for vaccination?** The target of any vaccination is to prime the adaptive immune system to a specific pathogen. Though specialized and highly effective, it can take days to weeks for the response to form the first time the body is exposed to that pathogen. This is because it takes time to produce immune components in high enough volumes to stop an infection. After that exposure via vaccination, the immune system can go back to that blueprint if it encounters the real pathogen. Depending on the type of vaccine and pathogen, that blueprint can be lifelong or require boosters (think of the polio vaccine versus the flu vaccine in humans).

2. **What are the methods of vaccination in fish?**
   - Injection: A water-based or oil-based vaccine is injected into the muscle or body cavity. This provides strong, lasting protection, but is more time-consuming.
   - Immersion: Groups of fish are placed in a vaccine bath (liquid vaccine diluted with tank water) for a set time, exposing the skin and gills to the antigen. Protection is not as robust as injection, but the process is much faster, especially when working with large numbers of juvenile fish.
   - Oral: Vaccine is added to the feed (mixed, top-dressed, or bioencapsulated). It is the simplest method of administration, but like immersion vaccine, duration of immunity can be short.
3. **When are vaccines useful?**
   - The use of vaccines is highly dependent on the individual facility. Purpose of the hatchery, fish species raised, medical history, culture practices, and biosecurity practices all play a role in decision making. It is important to recognize that vaccines are a tool in our chest against disease, not a silver bullet. A few situations where vaccines may prove beneficial are:
     - Facility with a history of a bacterial or viral pathogen, especially if fish culture and biosecurity changes have already been made to no avail.
     - Facility with strong biosecurity practices, but a high disease risk assessment. This could be a hatchery that is adjacent to a river with a high prevalence of disease in wild fish. Even with strong biosecurity practices, there is an innately higher risk that disease could jump to the farmed fish via predation, flooding, hatchery visitors, etc.
     - Broodstock facility with long-lived, highly valuable fish. Since these fish are on-station longer than a production fish, giving them the added defense measure may be beneficial.
     - A significant pathogen has been found in one lot of fish on-station. Fish have been treated or culled, and biosecurity measures are in place to mitigate spread, but you want to take further preventative action to protect the rest of your population for the future.

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