UNDERSTANDING FRESHWATER FISH BEHAVIOR
TO BECOME A BETTER FLY FISHER
The FFI Learning Center is a primary source of educational and instructional materials, to meet the needs and interests of the fly fishing community in the areas of FLY FISHING SKILLS, FLY CASTING, FLY TYING, and CONSERVATION. The Learning Center is a combination of annual in-person workshop instruction and downloadable instructional materials found on the FFI website.
FLY FISHERS INTERNATIONAL

» www.flyfishersinternational.org

» Nonprofit, national governing body

» Only organization to focus on the fly angler:
  “All Fish, All Water”

» Founded 1965 in Eugene, Oregon

» Fly Fishing Skills, Casting, Fly Tying, Conservation

» “Educating, Conserving & Restoring through Fly Fishing”

CONSERVATION / EDUCATION / COMMUNITY
WHERE ARE THEY AND WHAT ARE THEY DOING?

Learning Center  Module-Beta Version
A workshop prepared for the 2018 Fly Fishers International Fly Fishing Fair

Developed by David W. Peterson
FFI Board Board of Directors, Conservation Chair and Great Lakes Council VP for Conservation
» Educational Resources for New and Experienced Fly Fishers

» Web Based Information Center- videos, curricula, brochures, podcasts

» Four Focus Areas-Fly Casting, Conservation, Fly Tying and Fly Fishing

» Roll Out at 2018 Fair

» This program is a “beta” version
FIRST THING’S FIRST

INTRODUCTIONS

» Who are you? Where are you from?
» Where do you fish and what do you fish for?
» What do you want out of this?
» Beginner, intermediate, experienced?
A LITTLE ABOUT ME

» Currently live in Pentwater, MI—Heart of the Century Circle

» Fish or have fished in the Quetico and Boundary Waters Wildernesses, Labrador, Florida, Turks and Caicos, Maine, Montana, Minnesota, Michigan, Illinois, Wisconsin, New Zealand, Oregon, California

» Didn't say I caught in all those places
THOUGHTS FOR THE DAY

“There is a fine line between fishing and just standing on the shore like an idiot.” - Steven Wright

“...I need three more years before I can think like a fish.” - Paul in A River Runs Through It

“It has always been my private conviction that any man who pits his intelligence against a fish and loses has it coming.” - John Steinbeck
WORKSHOP OVERVIEW

We hope to shed some light on the behavior of freshwater fish and the implications of that behavior for the angler

SENSORY ABILITIES: VISION, HEARING, THERMORECEPTION, CHEMORECEPTION, OLFACTION, AND TASTE

COGNITIVE ABILITIES AND LEARNING

SEARCH IMAGE FORMATION

ENVIRONMENTAL FACTORS: TIME, TEMPERATURE, AND OXYGEN LEVELS

FEEDING BEHAVIOR

NEED FOR SHELTER, COMFORT, FOOD

LOCATION AND LIES—STREAMS AND LAKES

WATER CONDITIONS—TYPES, TEMPERATURE, ETC.

REPRODUCTIVE BEHAVIOR

HOPEFULLY, A BIT OF FUN ALONG THE WAY
A FEW BIG IDEAS TO KEEP IN MIND

(Borger, Presentation)

» Fish are wild animals and behave as such—“this should be the sole basis for your angling strategy”

» Thus, the angler becomes the “predator” and the fish the “prey”; prey behave in predictable ways
  » If there is a mistake made in this relationship it is usually the angler who screws up the predator side

» Understanding fish as the “prey organism” (e.g. what they see, hear, eat, and where they hide) will help you catch more of them

» Darwin’s Law rules: the fish that adapts best, lives longest and becomes the biggest
» Have to be more alert and adaptable to survive
» Hearing and vision highly developed to detect danger
» Easily aroused and scared by anything that doesn’t fit with natural surroundings
» Implication—minimize your presence in every way
SENSORY ABILITIES

To understand behavior we must take a look at sensory abilities

HUMAN
- Vision
- Hearing
- Smell
- Taste
- Touch

FISH
- Vision
- Lateral Line
- Inner Ear
- Combined chemoreception
- Underdeveloped
OTHER SENSES

» Thermoreception: changes in body temperature create behavior changes (e.g., fish line up next to a spring)

» Magnetoreception: magnetic fields

» Internal Reception: e.g., nociceptors detect noxious stimuli
» The Fish’s Eye: basically the same structure as other vertebrate eyes except no eyelid and pupil fixed

» Rods (process black and white for night) and cones (color image) for daytime

» Rods and cones more loosely packed so image is not as detailed as what we see

» Also reduced ability to see in three dimensions
VISION AND THE EYE

BUT!

» Highly adapted to detecting relative size, shape, shadows, etc.

» Highly sensitive to behavior of food (ex. a crudely tied fly may catch the fish if it is drag-free vs. dragging)

» This is why presentation is so important at times when fish are selectively feeding

» Predominant sense: once predator or prey are in visual range, other senses take a back seat
DAY AND NIGHT VISION

» Trout’s pupil is fixed, but it still tolerates sunlight quite well contrary to popular belief (e.g. feeding during the day)

» At night, rods take over and the eye becomes very sensitive to light (e.g. fish stop feeding in reaction to a bright light or moon, hex hatch)

» Night vision not as good as day vision but better than ours

» At night, avoid bright lights!
Fish’s color vision strongly affects ability to feed by seeing difference in color of different foods.

Same thing happens with predators (e.g. bright clothing).

Color perceived based on:

- Nature of the light (pm vs. am)
- Character of the water (clarity, tannin, etc.)
- Surface of the object (it’s color)
- Depth
COLOR

» There is a loss of color as depth increases (a red fly at six feet appears gray)

» General guidelines for some other fish like bass
  » Conditions of darkness (stained water, dark)—use dark colored flies or gaudy colors (chartreuse)
  » Bright light—use light colored flies (white, yellow, pale green)
COLOR—SOME OTHER CONSIDERATIONS

» Stained Water
  » Dark colored or gaudy flies
» Turbid or Muddy Water
  » Contrasting colors
» Worms are being washed in so try a San Juan worm
FIELD OF VISION

» Fish's field of vision

» Fish's window of vision (Snell's window) 97 degrees, size of course varies with depth
A BRIEF DETOUR INTO HOW FISH LEARN—
TWO CONDITIONING PROCESSES

» **Operant, Instrumental or Skinnerian Conditioning**—
learning in which the strength of a behavior is modified by its consequences, such as reward or punishment, and the behavior is controlled by antecedents called discriminative stimuli which come to signal those consequences.

» **Classical or Pavlovian Conditioning**—a learning process that occurs when two stimuli are repeatedly paired; a response that is at first elicited by the second stimulus is eventually elicited by the first stimulus alone.
### WHAT ARE THEY THINKING?

**NOT MUCH—JUST TRYING TO GET BY**

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## CLASSICAL VERSUS OPERANT CONDITIONING

<table>
<thead>
<tr>
<th></th>
<th>CLASSICAL CONDITIONING</th>
<th>OPERANT CONDITIONING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Response</strong></td>
<td>Involuntary, automatic</td>
<td>Voluntary, operates on environment</td>
</tr>
<tr>
<td><strong>Acquisition</strong></td>
<td>Associating events; CS announces US</td>
<td>Associating response with a consequence (reinforcer or punisher)</td>
</tr>
<tr>
<td><strong>Extinction</strong></td>
<td>CR decreases when CS is repeatedly presented alone</td>
<td>Responding decreases when reinforcement stops.</td>
</tr>
<tr>
<td><strong>Cognitive processes</strong></td>
<td>Organisms develop expectation that CS signals the arrivals of US</td>
<td>Organisms develop expectation that a response will be reinforced or punished; they also exhibit latent learning, without reinforcement.</td>
</tr>
<tr>
<td><strong>Biological predispositions</strong></td>
<td>Natural predispositions constrain what stimuli and responses can easily be associated</td>
<td>Organisms best learn behaviors similar to their natural behaviors; unnatural behaviors instinctively drift back toward natural ones</td>
</tr>
</tbody>
</table>
AN EXAMPLE OF OPERANT CONDITIONING

This is the antecedent

This is the behavior

Trout enjoys a tasty meal and the behavior is reinforced
SEARCH IMAGE FORMATION

» “Match the Hatch” vs. Match the “Search Image”

» If a search image is reinforced through multiple encounters, trout become selective (Swisher and Richards)

» When search image is not as strong (nothing hatching); trout will deviate and select different food species

» Also less discriminant as to criteria—e.g. size and color (searching patterns)
SEARCH IMAGE FORMATION AND THE CRITERIA TROUT USE TO VISUALLY SELECT FOOD

(Randall)

» Clues that predators use when evaluating potential food; a “template” formed over many prey encounters

» How it works
  » Search image established through operant conditioning
  » Successful behavior rewarded
  » Trout selects food; satisfies appetite; trout feeds again
  » The more this goes on, the stronger the connection
  » The more recent it is the stronger it is
  » If recency fades (e.g. that hatch ends for the season) the search image fades and another takes over
USE OF SEARCH IMAGE FORMATION CONCEPTS WHEN FISHING

» Size and profile are the first criteria the fish see
» First impression isn’t really detailed due to their vision
» Color, in and of itself, is a secondary consideration—important only after size and profile look good
» All things being equal, miss the color, not the profile
» Contrast between colors is a strong criteria
USE OF SEARCH IMAGE FORMATION CONCEPTS WHEN FISHING

» Behavior is an important part of the search image; how does this bug or prey behave?

» Bottom line: your fly should look natural (e.g. movement) and behave like what it is imitating

» Examples: swimming nymph should move, streamer should dart, dry should be drag-free, “Leisenring lift” for wet
USE OF SEARCH IMAGE FORMATION CONCEPTS WHEN FISHING

» Nighttime: when fishing at night color is relative unimportant; profile and contrast are everything

» Deviants (no not that kind of deviant!)
  » Heavy hatch: try something different, larger or smaller or a bright spot, movement
Based upon what we’ve talked about regarding **vision**, will your angling behavior change?
» Excellent sense of hearing

» Three sound receptors: inner ear, swim bladder, lateral line
  » Inner ear: maintains balance and spatial orientation; detects compression waves.
  
» Swim bladder: amplifies compression waves for inner ear; greatly increase range but these two together can’t tell the fish the direction of the sound
**HEARING**

- Lateral line: series of external openings connected to a canal lined with nerve endings
  - Primary sound receptor
  - Sensitivity: pretty incredible; can hear a dry fly hit the water six feet away
  - Use lateral line to detect slight changes in pressure as well
SOUND IN WATER

» Compression wave in water carries much farther and faster

» In swift water compression waves are washed away

» Items in touch with the water (e.g. boats, tramping on the banks) will transmit compression waves

» There are lots of compression waves so fish are bombarded by sound—it’s the unusual ones that alarm them
HOW FISH USE THEIR HEARING

- Avoiding predators
- Hunting prey—e.g. mousing at night, splatting a big hopper onto the water
- Determining if the prey is natural
HEARING AND ANGLING BEHAVIOR

» Duh! The quieter you are the better off you’ll be
» Talking is not a big deal due to the fact that air-to-water sound transmission is not as important
» Wading noise and bow waves create compression and can be more significant
» Borger—treat the river like you would a still lake on a quiet morning; cast and wade without a lot of racket
» Use flies that make noise when appropriate
Based upon what we’ve talked about regarding **hearing**, will your angling behavior change?
Thermoreception and Thermoregulation

How Does Temperature Affect Fish?

» Fish's thermoregulation is “behavioral”; being cold blooded they have to avoid thermal distress by moving

» Preferred temperature is based upon metabolism and amount of dissolved oxygen

» Amount of dissolved oxygen is directly temperature related
How Does Temperature Affect Fish?

» Metabolic rate rises and falls with temperature

» Fish seek areas where temperature is ideal for them (have to balance this with other reasons to choose a lie; e.g. safety, food, shelter)

» Fallacy that trout stop feeding in hot weather; they just change feeding patterns
# Temperature Sensitivity for Various Species

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>LOWER AVOIDANCE</th>
<th>OPTIMUM</th>
<th>UPPER AVOIDANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic Salmon</td>
<td>45</td>
<td>50-62</td>
<td>n/a</td>
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<tr>
<td>Bluegill</td>
<td>58</td>
<td>69-72</td>
<td>80</td>
</tr>
<tr>
<td>Brook Trout</td>
<td>44</td>
<td>58</td>
<td>70</td>
</tr>
<tr>
<td>Brown Trout</td>
<td>44</td>
<td>56-66</td>
<td>75</td>
</tr>
<tr>
<td>Coho Salmon</td>
<td>44</td>
<td>55</td>
<td>60</td>
</tr>
<tr>
<td>Largemouth Bass</td>
<td>50</td>
<td>65-75</td>
<td>85</td>
</tr>
<tr>
<td>Northern Pike</td>
<td>55</td>
<td>65</td>
<td>74</td>
</tr>
<tr>
<td>Rainbow Trout</td>
<td>44</td>
<td>61</td>
<td>75</td>
</tr>
<tr>
<td>Smallmouth Bass</td>
<td>60</td>
<td>65-70</td>
<td>73</td>
</tr>
<tr>
<td>Steelhead</td>
<td>38</td>
<td>55-60</td>
<td>n/a</td>
</tr>
</tbody>
</table>
TEMPERATURE SENSITIVITY

How does temperature affect where they are when it’s too hot?

» Trout have 3 goals when water gets warm:
  » More comfortable temperature
  » Avoid heat from the sun
  » Find higher oxygen content

» Freestone streams vs. primarily spring fed—fish may move more in a freestone stream due to greater temperature variations
TEMPERATURE SENSITIVITY

How does temperature affect where they are when it’s too hot?

- Look for springs, seeps, and feeder streams
- Undercut banks
- Whitewater, riffles or just below
- Feeding behavior may focus on cooler times of the day; morning and evening
TEMPERATURE SENSITIVITY

How does temperature affect where they are when it’s too cold?

» Look for springs again; they are the warmer water now

» Sunlight may become their friend for warmth; look at the sunny side of the stream

» Energy conservation takes over; won’t chase food far

» Look for fish where they can avoid strong currents; steady flow with food

» Need to take advantage of every feeding opportunity as less is available

» Feed more opportunistically so try different offerings
» Smell: 100 time more sensitive that humans

» For practical purposes we usually combine these two and simply talk of chemoreception in fish

» Not limited to mouth and olfactory organ; fish have other chemosensory systems

» Although less developed in trout, highly developed in barbels of the catfish
USES OF CHEMORECEPTION

» Food selection and acceptance (should I eat this or not?); highly sensitive to chemicals in food.

» Predator avoidance: sense chemicals from predators and are alarmed

» Reproduction and sexual behavior: pheromones signal readiness

» Governs the migratory behavior of anadromous fish
» Use sight (search image), hearing, and chemoreception to locate prey

» Use as little energy as possible in exchange for maximum food gain

» Don’t have a lot of time to make a decision; fast water even less
FEEDING BEHAVIOR—APPETITIVE AND CONSUMMATORY PHASES

» Appetitive phase
  » Anticipatory set develops in response to hunger
  » Mediated by olfaction
» Consummatory phase: mediated by vision
» Fish reject imitations because they don’t taste right
Feeding is Opportunistic or Selective

» Opportunistic—taking what comes along or is available

» Selective—feeding exclusively on one form of food to the exclusion of others
  » The result of conditioning to that food source due to the amount available; multiple encounters
  » Occurs during “temporal prey clumping” events; aka a big hatch
» Taking nymphs on the bottom—of course none

» Splashy rises—rising to active duns, caddis adults, active stoneflies, etc.—sometimes indicative of small fish

» Head rise (e.g. nose poking out)—rising to adults, often accompanied by bubbles
RISEFORMS

» Bulge or fin and tail rise—emergers or nymphs near the surface

» Sip rise—often very delicate, eating spinners or cripples
WHERE FISH ARE LOCATED—FISH IN STREAMS

» For fish, “life hangs in the balance between the amount of energy that it gets from its’ food and the amount of energy expended.” (Borger)

» Three types of lies—All three must provide some level of protection from the current
  » Sheltering Lie
  » Feeding Lie
  » Prime Lie
WHERE FISH ARE LOCATED—FISH IN STREAMS

» Sheltering Lie
  » Offers protection from predators
  » Generally doesn’t offer food
  » Generally under something (bank, log, deep water, swift currents)

» Figure out where they are as fish will head there when hooked
WHERE FISH ARE LOCATED—FISH IN STREAMS

» Feeding lies—fish go there for a meal
» Offer food, but not a lot of shelter
» Edge of riffles, gravel bars
» Tail of a pool
» In front of or behind a rock
FEEDING LIES

» Protection from currents
» Must provide food, floating or subsurface
  » Where currents are concentrated, food will be concentrated
    » Bubble line, banks, etc.
» Biggest fish take the best lies
» Offer food and shelter at the same time—find a prime lie and you’ll find the fish
» Usually under something
» Undercut bank
» Deep riffle
» Tangle of logs
ELEMENTS OF A STREAM

© Tony Bishop
LIES AND STREAM CHARACTERISTICS

» Pools—deeper and slower
  » Contain all three types of lies
  » Feeding occurs at the tail of the pools and at the edges
  » Also at the “lip” of the pool just below a riffle
LIES AND STREAM CHARACTERISTICS

» Riffles
  » Stream bed inclined, less than average depth, bottom is stone and gravel
    » Rocky bottom creates plenty of holding spots
    » Can offer all three types of lies
  » Source of a great deal of food
LIES IN RIFFLES

Riffle Lies
Prime Lies in Red

Trout Feeding at the
Edge of a Riffle

Current
Current flows downstream
toward the pool
» Run is deeper than riffle, shallower than a pool
» Water swifter than a pool
» Look for structure
LIES AND STREAM CHARACTERISTICS

» Reverse currents and eddies—a source of concentrated food
  » Confluence line where reverse joins the main current an excellent spot
  » Also look for foam concentrations
  » Fish may not be facing upstream
LIES AND STREAM CHARACTERISTICS

» Pocket water and rapids
  » Very steeply inclined
  » Lots of rocks/boulders
  » Pockets can be prime or feeding lies
FISH LOCATION IN HIGH WATER OR FLOOD

» High water changes the rules
  » Heavy flows change feeding lies and feeding lanes
  » Fish relocate around the margins of the stream or behind structure that offers protection
  » Target structure, edge seams, backwater eddies
Shelter, comfort and safety still apply as do the types of lies

Cruising lanes—food doesn’t come to them so they have to find it

“Edges” are important

Structure, structure, structure
FISH LOCATION IN PONDS AND LAKES

» Life zones
  » Littoral—plant zone
  » Limnetic—open water where light can penetrate
  » Euphotic—same as above, enough light for photosynthesis
  » Profundal—deep dark water, no light
  » Benthic—where insects, plankton, etc. are growing
LIFE ZONES
TEMPERATURE STRATIFICATION

» Epilimnion—layer of warm water at the surface
» Hypolimnion—cold layer below the epilimnion
» Thermocline or metalimnion—two layers are separated by a layer of water which rapidly changes temperature with depth.
TEMPERATURE STRATIFICATION AND TURNOVERS

» Fish move into different layers based upon temperature preferences

» Spring and fall turnovers also affect fish location
FISH LOCATION IN PONDS AND LAKES

Some Other Considerations

» Wind forms scum lines which concentrate food and attract fish

» Longshore (parallel) and rip currents (right angles) formed by wind and waves can also concentrate food
Based upon what we’ve talked about regarding feeding and lies, will your angling behavior change?
REPRODUCTIVE BEHAVIOR

TROUT LIFE CYCLE

- Fingerlings grow to mature adults.
- Mature trout deposit eggs in gravel nests called redds.
- Eggs hatch in a few months and are called clevins.
- Fry reach fingerling size (about 3 inches) after several weeks, depending upon water temperature and food.
- When the yolk sac is gone, the fry emerge from the gravel.
- Alavies remain in the gravel, living off the yolk sac.
REPRODUCTIVE BEHAVIOR OF TROUT

» Fall spawners—October through December
  » Browns and brookies

» Spring spawners—March through May
  » Rainbows and cutthroats
SPAWNING—TROUT’S LIFE GOAL

» Females spends days sculpting the redd—gravel and oxygen have to be just so, remove silt, etc.

  » Puts them in vulnerable lies

  » Strips away slime layer

» Lay 2,000-6,000 eggs per redd
SPAWNING—TROUT’S LIFE GOAL

» Male

» Show dominance against other trout

» Fight for the female and her redd—this can get pretty vicious

» Fertilize the redd

» Then protect it against intruders—doesn’t last long
**SPAWNING—TROUT’S LIFE GOAL**

» The chances of survival are slim
  » Everyone, including the parents, may eat the eggs
  » Predators eat the alevin
  » Predators eat the fry
» 2 to 4 years before surviving fish can reproduce
ETHICS OF FISHING FOR SPAWNERS

» Learn to recognize redds and don’t step on them

» Let spawning fish alone
  » Ensures more successful reproduction
  » May spare highly stressed fish and they’ll be back again
Books

» Borger, Gary. *Presentation*, 1995

» Randall, Jason. *Trout Sense*, 2014


» Rosenbauer, Tom. *Reading Trout Streams*, 2014
» Give us a call (630-533-1009) or email (dpeterson3@charter.net) if you’re coming to Michigan, and we’ll go fishing.

» Please take a few minutes to evaluate the workshop before you go.
The testament of a fisherman


I fish because I love to;

Because I love the environs where trout are found, which are invariably beautiful, and hate the environs where crowds of people are found, which are invariably ugly;

Because of all the television commercials, cocktail parties, and assorted social posturing I thus escape;

Because, in a world where most men seem to spend their lives doing things they hate, my fishing is at once an endless source of delight and an act of small rebellion;

Because trout do not lie or cheat and cannot be bought or bribed or impressed by power, but respond only to quietude and humility and endless patience;

Because I suspect that men are going along this way for the last time, and I for one don’t want to waste the trip; because mercifully there are no telephones on trout waters;

Because only in the woods can I find solitude without loneliness;

Because bourbon out of an old tin cup always tastes better out there;

Because maybe one day I will catch a mermaid;

And, finally, not because I regard fishing as being so terribly important but because I suspect that so many of the other concerns of men are equally unimportant – and not nearly so much fun.
TAKE A KID FISHING!
THANKS! HAVE FUN AND ENJOY THE BEAUTIFUL PLACES!
FLY FISHERS INTERNATIONAL has been an organized voice for fly fishers since 1964. We represent all aspects of fly fishing—from the art of fly tying and casting instruction, to the protection of and access to fisheries around the world.

A 501c3 non-profit organization, FFI is driven by three fundamental pillars: CONSERVATION, EDUCATION, AND COMMUNITY. Together, these pillars provide the foundation for our vision of the future of fly fishing—a future in which anglers have access to prime waters and fish can thrive in healthy, protected habitats; in which learning never stops and artistry is not forgotten; and that recognizes the true value of camaraderie. If we want this legacy to be experienced by future generations, we have to work to make that happen.

JOIN FLY FISHERS INTERNATIONAL TODAY to help ensure that fly fishing can continue to instill the kind of passion it does today in so many of us.

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