

Joining Physics and Phys Ed through Fly Casting

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*Visions for Our Future
Reflections on Our Past*

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***UAF SPORT FISHING
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Introduction

What is sport casting? It's a series of events that test or help anglers improve their casting proficiency in plug casting, spinning and fly-casting. There are both accuracy and distance games to help sharpen casting skills. Casting practice or competition is to the angler what trap or skeet shooting is to the hunter. Many people enjoy shooting and never go into the field hunting. The same enjoyment and challenges apply to casting. Whether the casting consists of individual practice or informal competition, it originated as a way of getting bait to the fish. It was a skill that had to be practiced and, when two or more fishermen were practicing together, it led to friendly competition that eventually led to more formal events.

Although little known to the general public, casting is actually one of America's oldest organized sports. The New York Sportsmen's Club began holding an annual fly-casting tournament in 1861, thirty years before basketball was invented. English and Irish fishermen had introduced fly-casting to the United States. Competitive casting may have begun in England, on a small, local scale, as early as the mid-18th century. The *Fishing Gazette* conducted the first British national tournament in 1881. From England, casting as a competitive sport moved into several Northern European countries early in the 20th century.

The Chicago Fly-Casting Club staged the first truly national tournament as part of the 1893 Chicago World's Fair. The American Casting Association (ACA), who sanctions competitive, casting events in the United States, was formed in 1960. However, casting didn't become an international sport until after World War II. In 1953, the *National Rod and Reel Association* (the predecessor to the ACA) invited several other national casting organizations to form a worldwide federation. As a result, the International Casting Federation (ICF) was founded in January 1954. Original members included Australia, Belgium, England, Finland, the Netherlands, New Zealand, Norway, Scotland, Sweden, and the United States. The ICF became known as the International Casting Sport Federation

(ICSF) in 2003. There are two basic types of casting competition, distance and accuracy, and four basic kinds of tackle: fly, bait, spin casting, and spinning. More information on the ACA can be found by logging on to <http://www.americancastingassoc.org>

Does this physical activity help anglers catch more fish? Absolutely, except for trolling or still fishing, casting skill is the most important element in fishing success. The better one can cast, the more success in fishing s/he will have. For example, a grayling is surface feeding. Can you place that fly in its immediate feeding zone? How often does an angler wish s/he could cast a dozen more feet to reach that slurping trout or marauding pike? Casting can be an end in itself because it is an intriguing, wholesome, recreational activity, but it also furnishes a powerful means to improve fishing techniques and skills which translate into more angling enjoyment.

A bit of casting teaching advice

Fly casting can be quite challenging to teach with larger groups. The author recommends an optimum class size of eight to 12. He has taught up to two dozen students in any single session. One such time was in his Spring 2004 UAF *Introductory Fly Casting and Fly Tying* course. To manage so many people, the instructor paired the students off to where there would be an 'observer' and a 'caster'. The observer watched to ensure the caster's line was not hitting the ground or coming dangerously close to trees and other people. In this way the primary instructor was more efficiently able to work with all students.

It should be noted some of the students in the Spring 2004 class were also designated as 'Volunteers' because they had some previous fly casting experience. This technique, used in the beginning lessons, was key to keep those with some casting skills from becoming bored and disruptive. It also helped bring all students to the same level of casting capability in remarkably few sessions.

Fly Casting as a Physical Education Activity

Can students use the same tackle that they use in fishing? They certainly can use their own fishing tackle for most informal and competitive events. Although for a class full of children (or adult) equipment may have to be borrowed so that everyone can participate without bottlenecks. Local Alaska Department of Fish & Game Offices and fly-fishing clubs may be able to help gather fly casting equipment, and they may also be willing to lend their expertise. This means that this activity could cost nearly nothing making it a great sport for children, families and schools. At the minimum, besides the fly rods, reels and lines, all that's needed are a few hula hoops and some open ground (or a gymnasium in the winter).

The next questions could include, "what are there rules" and "how do we play these games?" The American Casting Association (ACA) sets formal rules for the accuracy and distance games. An example appears in the appendix of this bulletin. ACA rules are probably too serious for beginners, and way too excessive for school children, but they can be adapted using a little creative license.

Whenever students are practicing casting, a piece of wool or a fly with the point removed should be tied on to the leader. The leader is that section of monofilament line between the fly line and the fly. Many anglers practice without a fly or piece of wool. This is wrong because a fly is to a line and leader what a tail is to a kite; it stabilizes the cast. Without it, the student's leader swishes back and forth and s/he changes his/her casting stroke to accommodate this effect. A piece of wool yarn, about the size of a # 10 fly (bright orange or yellow so that you can see it) is ideal. Another point: in practice, or actual fishing, always wear eyeglasses (sun glasses or plain) or safety glasses. Please make this a hard rule whenever students are casting. More than one person has lost his vision because he was fly-fishing without glasses.

When kids first learn how to throw a ball, rock, stick or snowball, and after they acquire the throwing motion, they want

to hit targets. They want to throw at objects: a garbage can, a tree, whatever. The same applies with casting. After students develop a casting stroke, and are comfortable with it, they need targets. Brightly colored Hula Hoops make wonderful targets on the ground. If you can't find Hula Hoops you can make your own targets from a variety of materials; foam craft circles work well. An old brightly colored rubber hose is also ideal. What you want to do is make three to six hoops that are about 30 inches in diameter. Use duct tape to secure the ends together. The closest target should be about 20 to 25 feet away and the longest target for the oldest kids should be no more than 45 feet out.

How Is It Done

Fly Casting Myths & Facts

Casting a fly rod requires no more coordination than swinging a golf club, baseball bat, or tennis racquet. Watching many anglers struggle with casting only makes it appear that way. Fly-fishing is not difficult. Unfortunately, this myth seems to be the main reason why people are reluctant to give it a try. With the appropriate equipment and proper instructions, novices should be able to cast the line reasonably well within a few hours.

When spin fishing, a lure is cast attached to a very thin line with a spinning rod. The lure has weight and this loads the rod to propel it towards the target. The fishing line is just along for the ride. When fly-fishing, you cast a fly line attached to a leader and fly with a fly rod. The fly is almost weightless. The leader it is attached to, which is usually around 9 feet long, is very similar to standard spinning line. This is attached to a fly line, which is usually about 90 feet long. The fly line is made of a flexible plastic and is much larger in diameter than spinning line and much heavier. When fly casting, the fly line provides the weight to load the rod and propel itself towards the target, with the leader and fly just along for the ride. It is very important to understand that you are casting the line, not the fly. The line and the rod have to be matched to each other in order to work

properly. A five-weight fly rod should be married with a five-weight fly line. The whole purpose of all of this, besides the grace and beauty of it, is to cast almost weightless flies and present them in the most delicate manner. Because it is not the same as casting a more heavily weighted lure with a spinning rod, it often takes several 'false' casts to load the rod with the desired length of line which will allow the angler to drop the fly where desired. In order to do this, sometimes it is necessary to cast the line a few times in the air, back and forth with the fly remaining in the air. This is what is termed 'false casting' and basically what is happening is that the rod is 'loading up' with the weight of the fly line, and more line can then be fed out to increase the length of line that is in the air, until the desired length has been reached and the angler can then set the fly down onto the water at the distance desired.

Fly casting follows facts of nature, laws of physics and natural forces such as gravity. Style is a different thing, each student may move differently, their bodies are different, and their senses and timing skills are different. There are a handful of generally accepted principles to good fly-casting technique:

A good grip should be one where the fly rod is grasped like a screwdriver with most of the force being imparted by the pinky and ring finger. The thumb should be on top of the cork handle. This grip should be firm, but not tight. If the student's forearm starts to tire, then s/he is gripping much too tight.

Start with the line straight. Just as it is impossible to pull a car with a slack rope, it is impossible to move a fly with a slack line. If the line is not straight movement is wasted to straighten it and effort is not only wasted, students will have the rod in a bad place to start. If the fly line is all piled up in front of the student, have her/him, place the rod on the ground (or floor), pick up the fly line, and walk it away from the fly rod until straight. While this method doesn't work on water, it does apply in a gymnasium or field.

Every casting stroke is a smooth acceleration followed by a stop. As shown later in the Physics section of this bulletin, rod speed has nothing to do with making a good cast; it is the acceleration and deceleration that matters. The acceleration bends the rod and loads it like a catapult. While it is accelerating the bend increases, when it stops the rod recovers and straightens. It is the stop that transfers the stored energy in the catapult (rod) to the line and makes the cast. That is why descriptions like “flicking the tip” or “painting the trim” are both applicable to casting. Most people understand that action and can replicate it. The harder the “stop” the further and straighter the fly line goes. The caster loads energy into the rod during the casting stroke. The rod releases the energy into the line in the cast. The caster loads a little energy (a short, low-energy stroke) into the top of the rod for short casts; he loads a lot of energy (a short, powerful stroke) into the middle and bottom of the rod for a long cast.

The line always follows the rod tip and when the rod stops the line projects in the direction that the rod tip was going in when the stop was made. This is perhaps the least understood rule but it is absolutely fundamental to the construction of every casting technique. Movement at the rod tip is produced every for direction that the line takes. For the line to go in a straight line, the rod tip must move in a straight line. The direction of the line is the same as the direction of the rod tip and the same thing goes for circles or parts of circles, eclipses or any other shape.

Good fly-casting is not strength-related; it is timing-related. Thus students must practice the timing of the cast to become good casters. How much practice? No more than 20 to 30 minutes at any one session is recommended. However, during a class, students can cast for 20 to 30 minutes, do another activity for 10 to 20 minutes and then cast for 20 to 30 minutes. Most anglers require considerable practice to develop proficiency in

fly-casting. The sheer amount of practice required to develop highly skilled casting techniques underscores the subtle mechanics involved in casting a fly line. Only a limited number of technical papers have addressed the underlying physics of the fly line during casting and these included in the references section of this bulletin.

Selected Lessons in Mathematics and Physics Derived from Fly-Casting

Fly-fishing differs significantly from other forms of sports fishing largely due to the equipment that the angler employs. In fly-fishing, an angler casts a lightweight artificial fly by using the distributed weight of the fly line. The motion of the fly line is controlled in part by the motion of the fly rod (and the angler) as well as by other forces including air drag, gravity and line tension. The casting action is achieved by establishing a nonlinear wave, simply referred to as a *loop*, that propagates along the line. Ultimately, this loop reaches the end of the fly line where it unrolls on or near the surface of the water. By contrast, in spin or bait fishing, an angler casts a lure, bait and or weight that has significant weight compared to the line to which it is attached. In this instance, the lightweight line remains largely straight and is simply pulled from a reel under tension.

Lesson 1: Dimensional Analysis (*this lesson helps to meet the 2005 Alaska Math Content Standards “A” & “B”.*)

Dimensional analysis, sometimes referred to as unit analysis, is a mathematical technique often employed by scientists to convert units from metric to English (and vice versa), and to change the units of their measurements. The following example deals with fly lines weights. As stated before, in fly-casting the line has the mass and is the object being cast. The fly

and leader are both just along for the ride. In the 1960's, the American Fly Tackle Manufactures Association (AFTMA) established a uniform system for sizing fly lines. An abbreviated chart appears below:

<u>Fly Line Size</u>	<u>Weight in Grains (for the first 30 feet)</u>
4	120
5	140
6	160
7	185
8	210
9	240
10	280

Not many people use grains in daily measurement. The underlying principle of dimensional analysis holds that all numbers can be multiplied by 1 or any fraction that equals 1. Therefore, the first 30 feet of a 5-weight line fly line weighs:

$$140 \text{ grains} \times \frac{0.064799 \text{ grams}}{1 \text{ grain}} = 9.07 \text{ grams}$$

Lesson 2: Gravity

(this lesson helps to meet the 2005 Alaska Math Content Standards "A" through "C", and 2005 Alaska Science Content Standard "B".)

To restate a previous point, good casting requires quick movements. Another term for this would be *acceleration*. To make a good cast, the student must overcome the force of gravity, which is defined as:

$$\mathbf{F}_g = \mathbf{M} \times \mathbf{A}_g; \text{ where,}$$

\mathbf{F}_g is the force of gravity measured in Newtons (N)

\mathbf{M} is the mass of the object measured in kilograms

\mathbf{A}_g is the acceleration due to gravity which is defined as 9.81 meters per squared second (m/s²)

Now, using the example of a 5-weight fly line, students can determine the force of gravity imparted on that line. First, they must convert the mass of the fly line to kilograms using dimensional analysis:

$$9.07 \text{ grams} \times \frac{1 \text{ kilogram (kg)}}{1,000 \text{ grams}} = \mathbf{0.00907 \text{ kg}}$$

Then:

$$\mathbf{F}_g = \mathbf{M} \times \mathbf{A}_g$$

$$\mathbf{F}_g = \mathbf{0.00907 \text{ kg} \times 9.81 \text{ m/s}^2}$$

$\mathbf{F}_g = \mathbf{0.0889 \text{ N}}$ of force imparted on the fly line.

So in order to begin to make a good cast, students must overcome the force of gravity. Since the mass of the fly line doesn't change, the students must accelerate

the fly line. It must be noted that speed does not equal acceleration. Speed is a velocity vector that describes distance traveled per unit time such as miles per hour or meters per second (m/s). On the other hand, acceleration is different. It describes distance traveled per time squared (m/s²).

Lesson 3: Torque

(this lesson helps to meet the 2005 Alaska Math Content Standards “A” through “D”, and 2005 Alaska Science Content Standard “B”).

Fly-casting students often ask, “how much wrist should I put into it”? This really becomes a physics question regarding torque. If the fly rod is treated as a third-class lever, then one part of the ‘wrist’ question can be logically answered. Torque is defined as:

$$\mathbf{T}_r = \mathbf{L}_r \times \mathbf{F}_c; \text{ where,}$$

\mathbf{T}_r is the torque created by the fly rod measured in Newton-meters (N-m)

\mathbf{L}_r is the length of the lever (rod) from the fulcrum to the tip in meters

\mathbf{F}_c is force caster is exerting on the lever (rod) measure in Newtons

First have the students find on the length of the fly rod. This is usually found just forward of the cork handle along with other information such as the proper

weight line to cast with the rod. Then have the students convert the rod length to meters by dimensional analysis:

$$8.5 \text{ feet} \times \frac{0.3048 \text{ meters}}{1 \text{ foot}} = \mathbf{2.59 \text{ meters}}$$

For this example, F_c is assumed to be 1 Newton. For the first torque calculation have the students use the full length of the rod:

$$\mathbf{T_r = L_r \times F_c \quad \text{or,}}$$

$\mathbf{T_r = 2.59 \text{ m} \times 1 \text{ N} = 2.59 \text{ N-m}}$ of torque produced. Next have the students work in pairs with our student gripping the rod as s/he would cast it, and the other student measuring from the butt of the rod to the caster's wrist. This example will demonstrate the reduction in torque when students bend their wrists while casting. Teachers can explain that they are effectively shortening the lever: In the 'wrist bending' example:

$$\mathbf{T_r = 2.45 \text{ m} \times 1 \text{ N} = 2.45 \text{ N-m}}$$
 of torque produced when the wrists bend

Then, if students instruct the students to keep their wrists stiff while casting and rotate their casting elbows they will effectively lengthen their lever (rods):

$T_r = 2.74 \text{ m} \times 1 \text{ N} = 2.74 \text{ N-m}$ of torque produced when the elbow is used instead of the wrist during the cast

Where teachers might be able to get casting equipment and help

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- Erik Anderson; Alaska Department of Fish and Game, Sport Fish Division; 1300 College Road; Fairbanks, Alaska 99701; (907) 459-7350
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- Ron Hulstein, University of Alaska Southeast; Juneau, Alaska, 99801; (800) 478-9069
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- Shann Paul Jones; Tanana Valley Campus, University of Alaska Fairbanks; P.O. Box 750134, UAF; Fairbanks, Alaska 99775-1040
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- Jon Lyman; Alaska Department of Fish and Game; P.O. Box 25526; Juneau, Alaska 99802; (907) 465-6186
-
- Midnight Sun Fly Casters; P.O. Box 81031; Fairbanks, Alaska 99708-1031
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**Appendix - 2005 ALASKA INTERNATIONAL
SENIOR GAMES FLY CASTING EVENT RULES**
Adapted from America Casting Association Rules

1. Equipment

A) Rod

i) Length - Shall not exceed nine feet, six inches (9'6") overall.

ii) Weight - Unrestricted.

B) Reel - Unrestricted.

C) Line - Unrestricted, but shall not be marked in anyway that would indicate distance, nor fastened to the reel at less than fifty (50) feet.

D) Leader

- Shall consist of a single leader of natural or artificial gut or gut substitute not less than six (6) feet in length.

E) Fly

i) Description - Official Fly provided by the Event Judge.

ii) Application - Only one fly may be attached to the leader at the tip end. The fly may be changed at any time, or a lost fly replaced with a fly approved by the Judge.

2. Target Course

A) Targets - Five (5) targets shall constitute the course. Each target shall be anchored so that the total movement for any reason will not exceed one foot in any direction. At no time shall the distance be less than the minimum distance specified in Section 2 B i or exceed the maximum distance specified in 2 B ii.

B) Distances

i) Near Target - The near target shall be placed from twenty (20) to twenty-five (25) feet, as measured from the center of the target to the center of the front edge of the casting box.

ii) Far Target - the far target shall be placed from forty-five (45) to fifty (50) feet, as measured from the center of the target to the center of the front edge of the casting box.

iii) Other Targets - The three remaining targets shall be placed randomly in the intervening space, and not in a straight line perpendicular to the casting box.

3. Time

A) General

- Time starts when the caster steps into casting box. Caster shall be allowed eight (8) minutes to complete the casting program without penalty.

B) Time Out - There shall be no time out for any reason, except for outside interference as determined by the Judge. The loss of a fly, unless that loss is caused by external contact such as a tree or a snag on a target, shall not be considered outside interference. The loss of a fly caused by striking any part of the casting platform shall not be considered outside interference.

C) Penalty - A penalty of three (3) demerits shall be assessed for each minute or fraction of a minute overtime.

4. Method of Casting

A) Casting Program

- General - The casting program shall consist of ten (10) final forward casts, two (2) at each of the five targets in the target course, in the order and as directed by the Tournament Captain. All five targets must be cast before any target may be cast again. Consecutive casts shall not be made on any target. Caster must enter casting box before beginning the casting program.
- Responsibility - After stepping into the casting box, the caster shall be responsible for the results and shall accept the score and penalties assessed by the Judge.

B) Casting Style

- Single handed (no spey casting)

C) Procedure

- Initial - Caster shall start with fly or leader in hand and no more than leader plus two feet of fly line extending beyond rod tip.
- False Cast - The false cast in which the line, leader and fly are moved through the air without intentionally striking the surface in front of the casting box is the mechanism for letting line out, pulling line in and measuring distance to the next target. The rod must be in motion, in the act of making a false cast, to strip line from the reel. Caster shall not

measure line by stripping along the rod. Caster has the option of holding any loose line in either hand or of letting it drop. Caster shall not allow fly to dangle or be blown over a target in spite of wind conditions.

- iii) Final Forward Cast - Whenever the intact line, leader and fly settles on the surface in front of the caster on a final forward cast, it shall be scored for accuracy (see Section 5). The fly shall float and be left floating a few seconds. After the Judge has ascertained whether or not the fly is floating, he shall call "Score" and the caster shall proceed to the next target.

D) Penalties

- i) Improper Strip - Should the caster strip line from the reel or pull line in through the guides while the fly is on the surface in front of the casting box and the rod is not in motion in the act of making a cast, or attempt to measure the line by stripping along the rod, it shall be scored an improper strip. A penalty of three (3) demerits shall be assessed for each such strip.
- ii) Improper Retrieve - Should the caster lift the fly from the water after a final forward cast before the Judge calls "Score" it shall be scored an improper retrieve. A penalty of three (3) demerits shall be assessed for each such improper retrieve.
- iii) Improper Cast - Should the caster allow the fly to dangle or to be blown over a target, it shall be scored an improper cast. A penalty of three (3) demerits shall be assessed for each such improper cast.
- iv) Fly or leader in Hand and no length more than leader plus two (2) feet of line extending beyond rod tip – A penalty of three (3) demerits shall be assessed for either infraction if caster fails to begin the round as specified in Section 4 C i.

E) Interruption of Casting Program

- i) Outside Interference - In the event the caster is interrupted during the Dry Fly round due to outside interference, as determined by the Judge, the caster, if they desire, may make a final forward cast to the last target scored. When the Judge is satisfied that the caster has the approximate line length required to reach the last scored target, they shall then notify the caster the time has started and the caster shall

lift the line from the water and proceed to the remaining targets. If the caster does not wish to cast to the last target scored, they may proceed as in Section E ii, except that time will start with the first false cast.

- ii) Other Interruptions - If the caster is interrupted during the Dry Fly round for reasons other than outside interference, the caster shall begin false casting and proceed to the remaining targets.

5. Method of Scoring

A) General

- i) No final forward cast shall be scored unless the line leader and fly are intact. The Judge shall notify the caster whenever they notice that the fly is off.
- ii) Each final forward cast shall be scored where the fly ultimately settles for more than one second.

B) Demerits for Accuracy

- i) A fly falling within or on any portion of the target on a final forward cast shall be scored a perfect and shall be assessed zero (0) demerits.
- ii) For each foot, or fraction thereof, the fly misses the extreme edge of the target on a final forward cast, a demerit of one (1) shall be assessed.
- iii) Maximum demerits for any single final forward cast shall be ten (10).

C) Demerits for Penalties

- Penalty demerits shall be in addition to accuracy demerits.

D) Caster's Score

- One hundred (100) points less the total number of demerits for accuracy and for penalties shall constitute a caster's score.

About the Presenter

Shann Paul Jones is Instructor of Outdoor Activities at the University of Alaska Fairbanks' Tanana Valley Campus Recreation Program where he specializes in adult outdoor recreation program development and delivery. Since the 2002 academic year, he developed and delivered nearly 50 college-level sport fishing clinics, workshops, classes and community outreach programs. In the last two years, enrollments in these programs are up nearly 400 percent. Jones' current research interests include assessing adult recreation education programs, and developing outdoor activities for people with developmental disabilities.

Jones has also worked at the UAF Geophysical Institute Operations Office as a Program Assistant since 2000. One of his more interesting tasks is taking bi-weekly absolute measurements of the earth's magnetic field for the U.S. Geological Survey. From 1992 until 2000, Jones worked as an Instructor and Science Technician for the Alaska Cooperative Extension Service where he presented a variety of non-credit recreational geoscience courses to the general public, and wrote a textbook on geophysical prospecting. Jones taught his first Alaskan fly tying and fly-fishing courses in 1987. Since then, he has taught for the U.S. Army Alaska Community Recreation Division, Fairbanks North-Star Borough Community Schools, and independently for small groups and individuals.

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Please visit our web site at <http://www.staff.uaf.edu/fnspj> to learn more about our program!