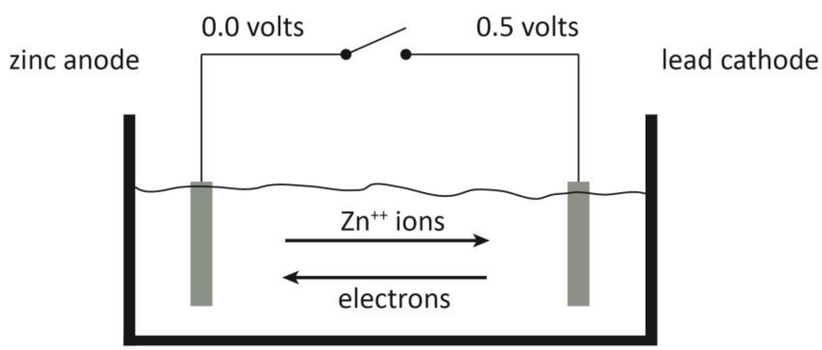
Salmon and Electric Fields
Part 2 History and Theory

In the 1940s and 1950s commercial trollers often found that some boats were "lucky" and fished well, while other boats were less successful. Sometimes a fisherman would upgrade to a larger boat and find that it did not fish as well as the previous boat. Usually the explanation was an electric field caused by stray electric currents or galvanic corrosion.

The first step in fixing this problem was to go through the boat carefully and bond the motor, the zincs, all of the electrical equipment and the through-hull fittings to a common ground. It was particularly important to ensure that there were no places where stray electrical currents could leak within the boat to a metal through-hull fitting. Fixing these issues reduced galvanic corrosion and in many cases improved the fishing, but did not necessarily make it a "lucky" boat. Eliminating the electric field is not enough -- the reason is that salmon are attracted to some electric fields and the problem is in getting the field right.

A boat typically has many metallic components which are exposed to the ocean. These metallic components may include zinc sacrificial anodes; aluminum, iron and steel in the motor and drive shaft; aluminum, chrome plated, stainless steel or bronze propellers; and bronze through hull-fittings. In those days the trolling gear typically included galvanized steel cables and lead downrigger balls. The result with these various metals was the equivalent of a battery, with the ocean forming the electrolyte.



The diagram above shows an example of a reaction between a zinc anode and a lead downrigger ball when both are immersed in seawater. If the zinc and the downrigger ball are not electrically connected within the boat the anode will release zinc ions (positively charged zinc atoms) while the downrigger ball will release electrons, until a charge builds up on both. Once the charge has built up the result is an electric field between the zinc on the hull of the boat and the downrigger ball. Depending on the alloys used, the voltage difference will be approximately 0.5 volts.

If the anode and the cathode are connected electrically they will both be at the same voltage and there will be no electric field between them. The reaction in the water occurs more readily and the zinc anode protects the other metal from corrosion (loss of ions) by collecting all the free electrons in the vicinity. This is the situation for an outboard motor with attached sacrificial zinc anodes.

It is easy to conduct a simple experiment at home. Add a tablespoon of salt to a bowl of warm water (to dissolve the salt quickly), and measure the voltage between a zinc anode and different cathodes. I used a hot dipped galvanized nail for the anode and various metals that I had around my shop for the cathodes. The table below shows the approximate voltage that you should see between the zinc anode (ground) and the cathode:

cathode material	**expected voltage**
aluminum	0.33 volts
lead	0.5 volts
stainless steel	0.8 volts

Your boat will likely have an aluminum outboard motor with several zinc anodes, and this represents ground. A downrigger with stainless steel cable and a lead downrigger ball should have a voltage of between 0.5 and 0.8 volts relative to the zinc anode. This voltage will vary depending upon the alloys used in the metals, and salmon are very sensitive to the voltage.

During the 1960s Russell Electronics in Victoria supplied electronic equipment to commercial trollers to control the electric voltage of their fishing gear. These devices were called “black boxes” and were popular in the fleet. Then in 1979 Daniel Nomura completed his master’s degree in science (zoology) at the University of British Columbia with the publication of his thesis “The Effect of Weak Electrical Fields on Troll Success for Spring (Oncorhynchus Tschawytscha) and Sockeye (Oncorynchus Nerka) Salmon”. Although he was simply testing the effectiveness of what was by then standard practice in the commercial trolling fleet, his master’s thesis is fascinating and even today is worth reading carefully. It is available at my website www.thescienceofsalmonfishing.com in the fishing notes section.

Nomura conducted the tests on his father’s commercial troller during 1978. They fished the Strait of Georgia at the mouth of the Fraser River just outside the drop off zones, and also Gabriola Island on the west side of the Strait.

When fishing for chinook he ran three main lines on each side of the vessel, with three to four sets of terminal gear per main line. Identical terminal gear was run on each side.

The natural voltage of the gear was measured to be 0.3 volts plus/minus 0.1 volts. The trolling gear on both sides was then grounded to the vessel common ground (bonded to the zincs and all metal which contacted salt water) and preliminary tests were conducted to verify that a similar number of salmon were caught on each side.

Then during the main experiments the trolling gear on one side of the vessel was grounded, while the voltage of the gear on the other side was controlled using a black box supplied by Russell Electronics. Nomura varied the black box voltage in 0.5 volt increments. He found that chinook salmon preferred plus 0.5 volts over the other voltages (positive and negative) that he tested. While the immature chinook (age 0.1+, a salmon which had been in the ocean for less than one year) didn't seem to care about the voltage, the older chinook preferred 0.5 volts to ground by a ratio of approximately 2:1. During the tests he caught 55 adult chinook on the 0.5 volt side and 28 adult chinook on the grounded side.

In the years after Nomura conducted his research black boxes became available to the recreational fishing fleet. Their popularity has declined recently with the introduction of ultra-high molecular weight braided polyethylene (two tradenames are Spectra and Dyneema) downrigger line, which provides less drag than the stainless steel downrigger line and is easier to handle. Unfortunately the braided line is an insulator so cannot be used to generate an electric field below the boat. When using braided downrigger line the result is similar to using stainless steel line which is bonded to vessel common ground – any electric field generated by the boat is eliminated.

In 2002 I made a trip to St Johns Lodge in Caamano Sound as a guest, and out of curiosity brought with me a good quality digital voltmeter. The boats were welded aluminum center consoles with 75 hp Honda outboard motors, and had Scotty downriggers spooled with stainless steel line. I measured the natural voltage to be 0.75 volts. We had excellent fishing that trip.

My personal fishing boat is an older model 17 ft Double Eagle which is made of fiberglass. A few years ago I stripped the boat to the hull and converted it into a center console specifically intended for salmon fishing. The first season back on the water I ran braided downrigger line (equivalent of ground potential) on the port side and stainless steel downrigger line with a "black box" on the starboard side. That season my biggest chinook was on the starboard side. More recently I've been running stainless steel line with the black box on both sides and the boat fishes even better. I think that running stainless steel line on both sides increases the area covered by the boat's electric field and draws the salmon in from a greater range.

In part 3 I'll describe how to measure the "natural" voltage of your boat, and how to rig the boat for operation with a black box.

Bill Haymond is author of "The Science of Salmon Fishing", which is available at www.thescienceofsalmonfishing.com. He is an electrical engineer and has spent his career in the research and development of digital radio systems. Bill is now retired from both engineering and guiding.