

Developing an Environmentally Responsible Irritant for the British Columbia Octopus Dive Fishery

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Abstract: Bleach has been used for decades as an irritant in the British Columbia (BC) commercial octopus dive-fishery. Recently the FAO (United Nations Food and Agriculture Organization) declared that using noxious substances in any fishery is considered unlawful, under international law. Canada's Department of Fisheries and Oceans (DFO) has asked BC octopus fishers to alter their fishing practises to bring them into accord with the FAO declaration and what will be Canadian Law.

This paper considers the relative merits of prohibiting bleach in all fisheries and then discusses the current efforts in Northern BC to resolve this concern – including the results of informal dive tests that used a variety of alternative irritants in fall/99.

The recommendations in this paper are based on a common sense trade-off between the cost-effectiveness, the safety-in-use, and the environmental friendliness of various irritant solutions. It is the considered opinion of the authors that, when political considerations are ignored, dry-bleach in solution is the best irritant for the BC octopus fishery at this time – suggestions were also made for further testing of other irritants.

Keywords: Fishing irritant, octopus fishery, gear-use, environmental harm, externality, field-testing.

1.0 Introduction -- The Nature Of The Problem

Dive-fishers need a means to extract octopus from their dens. When octopus are not hunting or travelling, they den-up to protect themselves from predators, including larger octopus (Barnes, 1969, pp.354-355 and 358-361). Dive-fishers hunt octopus during the day when octopus are normally denned-up in rocks or dug-in under 50-90 tonne boulders. The most common extraction method uses an irritant solution to drive an octopus out into open water where it can be harvested.

Octopus has been harvested from BC beaches for nearly a century. Traditionally, beach harvesters commonly used "blue-stone" (copper-sulphate; CuSO_4) to harvest octopus for halibut bait. However, blue -stone was recognized as a powerful biocide -- careless use of it can contaminate a site for a very long time. Thus, when scuba-divers began to harvest octopus in BC in 1979 (Esmonde, 1979; Silver, et al., 1991) the use of blue-stone had been prohibited.

A dilute solution of sodium hypo-chloride Bleach became a standard irritant for the dive fishery -- it is simple, cost-effective, safe to transport, and safe for the diver using it. The domestic sodium hypo-chloride bleach (2.0 percent Chlorine) was diluted three parts to one by water (a 0.067% solution) and delivered using a two litre Florence-Nightingale enema-bulb -- typically one quarter of the bulb was used per den. This tiny volume of bleach per den (e.g. ≈ 3.33 gm of chlorine; $.02 * 2000 / 3 / 4$) disperses rapidly and divers report new octopus re-inhabiting treated dens within 24 hours of treatment.

However, before the bleach is rapidly diluted, it drives crustaceans out of the den and is highly toxic to small fish in the den. Thus, using sodium hypo-chloride bleach as an irritant has a real issue -- short-run toxicity to small fish.

Current efforts to ban bleach are political and have little to do with reason or avoiding environmental harm (e.g. the Chlorine released per den is about the amount released into the environment from washing one load of laundry).

World opinion has been manipulated into thinking of bleach as an inappropriate input to sustainable fisheries. As a result, using bleach as a fishing irritant is not and can never be politically correct -- even though homeowners, water-treatment centres, sewage-treatment centres and most pulp and paper mills will continue spewing many thousands of tonnes of chlorine into Canadian waterways. In contrast, DFO's tough enforcement of laws on the use of sodium hypo-chloride bleach by divers will prevent 25-50 kg of chlorine ($3.33 / 1000 * 100 * 2204.6 / 30$) from being dispersed into the oceans.

However, government hypocrisy in allowing greater evils to continue unchallenged while vigorously legislating and enforcing against a very small evil is not a good reason to accept the small evil. The public relations desirability of replacing sodium hypo-chloride bleach with a more environmentally friendly fishing irritant is conceded by most dive-fishers of octopus.

2.0 The Search For Solutions

In their review of octopus biology in BC fisheries, Gillespie, Parker and Morrison (1998, pp.44-45) raised concerns about the use sodium hypo-chloride bleach as an irritant in the fishery. Octopus dive-fishers on BC's north and south coasts agreed to test other substances and to submit their test results to DFO.

The Octopus Development Institute (ODI), representing the north-coast octopus dive-fishers, established the following criteria for judging success in the search for an environmentally responsible irritant:

- a) Minimizing short-run and long-run harm to the site and the environment,
- b) Cost-effectiveness (cradle to grave), and
- c) Ease and safety of transport and use.

ODI recommended that dive-fishers test various solution strengths of such things as:

- a) Acids -- vinegar (acetic acid),
 - tannin (tannic acid),
 - citric acid (lemon, lime, or grapefruit juice),
 - oil from orange or lemon peels,
 - formic acid, and
 - muriatic acid (37% hydrochloric acid),
- b) Caustics -- cooking lye,
 - hydrogen peroxide (45%), and
 - ammonia.
- c) Salts -- ammonium nitrate (45-0-0 fertilizer), and
 - potassium chloride and/or calcium chloride.
- d) Electro/thermal/mechanical -- compressed air,
 - fresh water,
 - hot water,
 - sound, and
 - electrical shocks.
- e) Pharmaceutical -- caffeine, and/or nicotine,
 - bitrex and/or bitter aloes.

and that the results of these tests be directly contrasted with those of the sodium hypo-chloride bleach solutions.

The idea is to initially use highly concentrated solutions to visually identify those solutions that are very effective (e.g. rapid response to the solution by the octopus).

Testing to determine the minimum effective dilution of the irritants would then be done on the most cost-effective solutions. A further sort of the cost-effective solutions will be based on the trade-offs between their cost-effectiveness and environmental friendliness.

As expected most of the fishers listened carefully to comments from DFO and ODI, chose to experiment in secret, and promised they would share their results, after

the tests. However, one dive-fisher (Mr. Esmonde) agreed to work with and release his findings to ODI.

3.0 Selection Of Irritants For Testing

Mr. Esmonde has 35 years experience as a commercial diver and fisher. After reviewing the list of irritants proposed for testing by ODI he used his experience and knowledge of octopus behaviour to eliminate a number of irritants as being impractical, dangerous, or too costly:

- a) Too dangerous to handle -- hydrogen peroxide (45%),
 - muriatic acid,
 - cooking lye, and
 - formic acid.
- b) Ineffective -- compressed air (octopus hunkers-down),
 - sound (difficult to place, costly to produce, and
 - electric shock (difficult to place, potentially dangerous to the diver, costly to produce and costly to maintain in a saltwater), and
 - fresh water (octopus hunkers-down).
- c) Too costly or difficult to obtain
 - bitrex and/or bitter aloes,
 - citric acid (lemon, lime, or grapefruit juice),
 - tannin (tannic acid), caffeine, and/or nicotine,
 - oil from orange peels, and
 - hot water.

Mr. Esmonde agreed to test:

- vinegar (acetic acid)
- ammonia (urea),
- ammonium nitrate (45-0-0 fertilizer), and
- potassium chloride and calcium chloride,

and suggested a test of -- dichloroisocyanuric acid salts (pool shock).

4.0 Testing For Environmentally Benign Irritants

Mr. Esmonde and Capt Rene Lussier tested the solutions listed in the last part of section 3.0 during a seven-week voyage from 15 Oct/99 to 3 Dec/99. The tests involved three areas on 250 miles of BC north-coast shoreline from Prince Rupert to the bottom of Aristazible Island. During testing, tissue samples from harvested octopus were taken for inclusion in a DNA inventory that is controlled by Dr. Dan Heathⁱ. The details and results of the fishing-irritant tests are given in Table 1.

5.0 Discussion

Mild irritants such as fertilizer KCl and CaCl salts appear to have little effect on octopus. This is consistent with the response of octopus to fresh waterⁱⁱ.

Vinegar and ammonia are sporadically successful fishing irritants and, at (respectively) 75¢ and 60¢ per den, are prohibitively expensive when compared to 20.83¢ per den for the very effective sodium hypo-chloride. There is likely to be little or no enthusiasm for a shift from bleach to vinegar or ammonia as fishing irritants.

Dichloroisocyanuric acid salts (pool shock) is acceptably effective as a fishing irritant (on average an octopus will leave the den within two minutes of treatment) and the cost of 0.55¢ per den would make this a popular substitute for sodium hypo-chloride (e.g. it is 2.6 percent of the cost). Further, small fish were observed swimming away from the den after the treatment -- a similar treatment with sodium hypo-chloride produces seizures and death in small fish.

The reduced environmental harm and the desirability of using pool shock as a fishing irritant were confirmed during discussion with Jake and Colleen Vanderhyde (octopus dive fishers from the BC North Coast area).

Table 1: Fishing-Irritant Test Details and Results

IRRITANT	DILUTION	COST	QUANTITY	\$ PER DEN	EFFECTIVE	COMMENTS
1) Fertilizer (45-0-0)	56.67gm/2litres	\$10.00	1 Kg	14.17¢	No	No movement by octopus
2) Salts (KCl & CaCl)	Granules on skin	na	na	na	No	No movement by octopus
3) Vinegar	Full strength	\$1.50	1 Litre	75.00¢	Uncertain	Intermittent success
4) Ammonia	1 litre/2 litres	\$2.40	1 Litre	60.00¢	Uncertain	Intermittent success
5) Dichlorisocyanuric...	56.67gm/3.6litres	\$21.10	20 Kg	0.55¢	Yes	Takes about 2 minutes
6) Sodium hypochloride	1 to 3 parts water	\$1.50	3.6 Litres	20.83¢	yes	Instant and violent response

7.0 Recommendations

ODI recommends that Dichloroisocyanuric acid salts (pool shock) be accepted, on an interim basis, for use as a fishing irritant for a couple of seasons until even more environmentally-responsible fishing irritants are found.

Whatever fishing irritants are ultimately accepted for use in the fishery must:

- be perceived as being immediately life-threatening (or the octopus will hunker-down in its den),
- remain in solution while in use (not precipitate out),

6.0 Conclusions

Dichloroisocyanuric acid salts (pool shock) appear to be an ideal replacement for sodium hypo-chloride bleach. Specifically, it is acceptable to dive fishers as a fishing irritant, it disperses rapidly leaving no residue in the den, it appears to cause much less short-term harm to non-target species and (at 0.6¢/den) it is cost effective.

However, pool shock is unlikely to be politically acceptable -- it is a dry bleach that releases chlorine into the ocean. Fortunately, the 0.85g of chlorine released at the test concentrations (.12*56.67/2/4) is only a quarter of the chlorine released by use of sodium hypo-chloride bleach -- the expected annual release of chlorine in the dive fishery will be 5 to 13 kilograms.

- flush rapidly from dens and disperse rapidly into the water column (i.e. it must not accumulate in the den or in the immediate habitat), and
- have minimal long-term environmental consequences -- either via dilution or because the irritant breaks-up into harmless products.

While pool shock fits the above requirements admirably, ODI recognizes that the use of chlorine as a fishing irritant is not politically correct and, also, recommends that the following potential fishing irritants be tested during the fall/2000 test fishery:

Table 2: Fishing-Irritants Recommended for Testing

IRRITANT	DILUTION	COST	QUANTITY	\$ PER DEN	COMMENTS
1) Muriatic acid (HClO ₃)	0.06/2litres	\$30.00	1 Litre	22.50¢	Hazardous – Acid to water only
2) Ostrem bilge cleaner	0.05/3.6litres	\$1.40	1 Litre	0.49¢	Approved for fishboats DFO #5534-3
3) Tobacco infusion	2.0g/2 litres	\$25.00	90 Grams	13.89¢	Can be recycled using butts
4) Cooking Lye	1.0/7.2 litres	\$2.20	1 Litre	15.28¢	Hazardous – mix prior to use
5) Ground Starfish	1 per 6 litres	na	na	na	Use juice only – keep bits out of den
6) TSP	10 gm/1 litres	\$3.75	450 Grams	4.17¢	Must remain in solution during use
7) Alum (KAl(SO ₄)•12(H ₂ O))	10 gm/1 litres	\$4.50	125 Grams	9.00¢	Must remain in solution during use

7.0 References

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End Notes

ⁱ The original DNA inventory agreement was established in 1998 when Dr. Heath was at the University of Northern British Columbia -- as of Aug/2000 Dr. Heath and the DNA inventory will be at Windsor University, Ontario).

ⁱⁱ Salinity of 27-38 percent appears to be crucial (Forsythe and Van Heukelem, 1983, pp.151-152; Hartwick, 1983, pp.281). Octopus dofleini "...larva showed a sinking response in waters of low salinity. ...[which] may explain some areas with considerable fresh-water runoff may have octopus limited to deeper waters (Hartwick, 1983, pp.287-288). Adults of other octopod species have been observed to react "to low salinities by staying in their dens (where they died) rather than moving to avoid low salinities" (Forsythe and Van Heukelem, 1983, p.152).