Sea duck predation on mussel farms: a growing conflict

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The cultivation of blue mussels (*Mytilus edulis*) is a growing industry worldwide; however predation by migrating sea ducks has become an enormous challenge to mussel growers causing extensive financial losses. Mussels are a principle prey item for sea ducks, which take advantage of mussel farms that provide a highly abundant and easily accessible food source. Because cultivated mussels tend to have higher growth rates, thinner shells, and higher flesh content than intertidal mussels, farmed mussels are especially appetizing to migrating sea ducks (Galbraith 1992, Kirk et al. 2007), and a small flock can decimate a farm in a short period of time. To protect their farms, growers have adopted several techniques to deter ducks (including loud recordings, cannons, shooting, chasing, etc., see Table 1) but all have had limited success and often lead to habituation (Galbraith 1992, Ross and Furness 2000).

Feeding on cultivated mussels appears to be a learned behavior and deterring it is difficult. Considering that sea ducks are long lived (>15 yrs) and mussels are their preferred prey, it is not surprising that predation and conflict with growers is increasing. Although sea ducks generally prefer to dive in shallow water (<10 m deep), some species routinely dive to >30 m (Richman and Lovvorn 2008). While no scientific studies have quantified the amount of mussels removed by ducks on mussel sites; it is thought that duck predation has contributed to over 25% of mussel seed loss at mussel farms near Marie Joseph, Nova Scotia in the past (Bruce Hancock, AANS, pers. comm.). In spring of 2011, growers in the Baie des Chaleur, Québec experienced a devastating predation event reporting 50–60% loss of collector lines in only a few weeks despite continuous harassment with boats (Stephane Morissette, Les Moules Cascapédia, pers. comm.).

Currently, attempts to reduce predation are limited to bird scaring devices used to ‘scare’ ducks off mussel farms which include loud recordings, pyrotechnics, shooting, chemical deterrents, or boat chasing (Littauer 1990, Littauer et al. 1997, Ross and Furness 2000, Ross et al. 2001). In Atlantic Canada, protective socking material has been tested (Dionne et al. 2006, Mallet and Carver 2008), however results have indicated that the socking material may impact mussel growth rates and has limitations during production and harvest (Dionne et al. 2006). Raft culture structures have used predator control nets which are highly effective (Rueggeberg and Booth 1989). However, in areas prone to winter sea ice or sites using long-line culture, predator control nets are not practical at the scale of a large, long-line farm.

RECOMMENDATIONS TO REDUCE SEA DUCK PREDATION ON MUSSEL FARMS

- Be active on the farm. Human activity on the farm site has been shown to reduce the presence of birds; however some species will feed at night (scaup, long-tails).
- Buoys act as decoys, attracting ducks to the site - Sink Your Buoys. If possible, use the minimum number of buoys at the surface that are required for site marking. Chase off as soon as the first bird is seen on site; one will attract more.
- Use a combination of methods, randomly but consistently. Alternate between methods and intensity and use, followed by lethal shooting to reinforce when heavy predation (requires permit, often limited to farm site).
- Conserve and restore alternative habitat – give the birds somewhere else to go.
- Increase raptor habitat or nesting platforms near mussel lease sites.
- Protect collector lines (spat and 1y) as they are the preferred size of all species of ducks; although larger species can and will eat larger mussels. Ducks will attack harvest size lines, but often 'knock off' mussels when searching for 2nd or 3rd set. If possible, keep collector lines on the inside of the farm or use a raft which can be protected by a net or salmon cage.
- Before selecting farm sites, consult with local wildlife officials to discuss the areas of potential conflict and avoid sites in or near primary staging areas for sea ducks. Avoid sites near a known nesting colony.

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Table 1: Deterrent methods employed by the mussel industry to reduce sea duck predation.

Type	Device or method	Effectiveness	Notes & Comments
Auditory (sound)	**Gas cannons**	Variable short term, habituate	Produce load, sudden noise (bangs, flash of light); rapid habituation. Must be used in combination with other methods and comply with local noise ordinance or nuisance regulations. May require a permit.
	Shooting blanks or starter pistols	Variable short term, habituate	Produce load, sudden noise (bangs, flash of light); rapid habituation. Must be used in combination with other methods. Any use of firearm requires a permit.
	Pryotechnics (fireworks)	Variable short term, habituate	Produce load, sudden noise (bangs, flash of light); rapid habituation. Must be used in combination with other methods. May require a permit.
	Electronic: Distress calls, Predator calls, Hydroacoutics, Ultrasonic wailers	Variable short term, limited or unknown, habituate	Sonic or ultrasonic devices that transmit sound either above or below the water. Hearing range of sea ducks is unknown, effectiveness unknown; rapid habituation.
Visual	**Human activity**	Very good	Human activity and presence on site is the best deterrent, but generally only daytime hours.
	Boat chasing	Variable, good, habituate	Initially very effective for small flocks, but effect is reduced over time or when large flocks are present. Very expensive in labor and fuel. May require a permit and may be restricted to within 50 m of lease site.
	Scarecrow, plastic owl	Minimal	Inexpensive, rapid habituation.
	Kites, flags, streamers, balloons	Minimal	Inexpensive, rapid habituation. Often damaged in high wind.
	Scary eye buoy	Minimal	Yellow buoy with red and black eye; rapid habituation.
	Laser	Minimal	Ineffective in daylight, requires specialized and expensive equipment and training of operating personnel.
	Mirrors, reflectors, lights	Minimal	Inexpensive, rapid habitation.
	Radio-controlled aircraft	Minimal	Labor intensive, weather dependent and may require a permit.
	Corpses	Minimal	Limited and localized effect. Requires permit.
	Falconry (hawks and eagles)	Variable, good	Can be effective if used regularly and consistently. Few Falconers available and illegal in some countries. Requires many permits.

Chemical	**Gas cartridges**	Minimal	Not well adapted for marine use.
	Taste repellents	Minimal	Not well adapted for marine use.
Exclusion	**Nets - raft culture**	Very good	Nets of <5" stretched dimension (e.g. 2.5" x 2.5" square) are very effective on raft culture sites. Recommended to use with nets that cover the entire raft (sides, bottom and top) to be most effective. Initial investment is high to purchase and install. High fouling rates; expensive to clean, maintain and repair.
	Nets - long-line culture	Variable	Nets around the perimeter of a long-line farm may be limited to small farm sites and highly specific to areas of eider predation. Very expensive, high purchase, installation and maintenance costs. Requires permit and regulatory concerns (Navigable Waterways Act and concerns for entanglement/bycatch).
	Protective socking material	Variable	Several types of protective socking material (100% biodegradable cotton, cotton polyester blends, polyester, plastic) of varying designs have been tested. Studies have shown some success with protection from ducks, but requires improvements to time of biodegrading, fouling, and effects on mussel growth.
	Cages on individual drops	Good	Wire mesh cages for each individual drop (not appropriate for continuous lines). Labor intensive, high fouling rates, and expensive to clean and maintain. Limitations during harvest.
Lethal methods	**Shooting**	Good	Shooting to kill individuals is effective, especially as a periodic reinforcement to other methods at times of intense predation. Short term advantages as new flocks migrate through. Depredation permit required.
Habitat enhancement	**Alternative feeding sites**	Variable	Providing a 'sacrificial' mussel site has short term effect. Can attract more ducks to the area. Or conserve and enhance wetland habitats.