The Potentials and Challenges in Linking Local Ecological Knowledge with Marine Fisheries Research: The Case of White Hake (*Urophycis tenuis*) Predation on Juvenile American Lobster (*Homarus americanus*)

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Research Context

- Local fish harvesters claim increased and frequent observations of white hake predation on juvenile lobster within St. Georges Bay, Southern Gulf of St. Lawrence (sGSL), thereby posing a threat to recruitment of lobster into harvestable biomass. Increased predation is attributed, among other factors, to the Canadian government moratorium on commercial fishing for hake.
- The moratorium has greatly increased small boat harvester livelihood dependency on the lobster fishery. As a result, any factor judged as threatening to recruitment into the harvestable biomass is interpreted as a threat to the viability of fishing livelihoods.
- Local harvesters claim Fisheries and Oceans Canada's marine research has failed to document increased hake predation on juvenile lobster because field sampling occurs at the wrong time of the year and in the wrong places.
- Local harvesters request that university-seated researchers affiliated with Interdisciplinary Studies in Aquatic Resources (ISAR) and Social Research for Sustainable Fisheries (SRSF) at St. Francis Xavier University (StFX) design and launch a study to examine their concerns.

Objectives

The ISAR-SRSF group design and conduct a study on harvesters' local ecological knowledge (LEK) with the following specific objectives:

- To identify systematically the locations where and times of years when harvesters think it is important to conduct marine sampling in order to document the scale of hake predation on juvenile lobster.
- To determine the extent of groundfish predation on juvenile lobster through stomach sampling.
- To explore how social research methodologies can contribute to an integration of local knowledge in fisheries research.

In order to finance and to conduct the study, ISAR-SRSF researchers develop a collaboration with the local area's fish harvester representative organisation, the Gulf Nova Scotia Bonafide Fishermen's Association (GNSBFA), and Fisheries and Oceans

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A Collaborative Social and Marine Science Research Process

The Collaborative Research Process

Telephone Survey - Telephone survey of a stratified random sample of lobster license holders in Lobster Fishing Districts 26A and 26B (questionnaire is available at: www.stfx.ca/research/srsf).

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Rank-order of Local Experts - Peer-recommended list of 'local knowledge experts' is generated by rank ordering from most to least the number of mentions persons received when survey participants where asked: "Aside from yourself, who would you say knows the most about the local fishing ground?"

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Face-to-face Interviews - Beginning with those receiving the most mentions, semi-structured, face-to-face interviews are held with peer-recommended local knowledge experts associated with Cribbon's Point and Ballantynes Cove small boat harbors and communities, St. Georges Bay (interview schedule is available at: www.stfx.ca/research/srsf).

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Identify Predation Sites - The interviews solicit experiences and knowledge respecting white hake and lobster fisheries, including observations of white hake -lobster predation. On nautical charts, peer-recommended local knowledge experts are asked to identify sites where and the time of year when predation is most likely to be observed. A minimum of three independent observations were required for a site and time of year to be recommended for sampling. Interviews are completed with the recommended local experts until it is established that no new important information is likely to be forthcoming (i.e., achievement of information saturation).

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Roundtable Opinion Survey - While face-to-face interviews are being completed, an opportunistic sample of consensus opinions respecting the locations and times of year when hake predation on juvenile lobster is likely to be observed. This opportunistic sample is taken, employing nautical charts, from a group of fish harvesters attending a round table discussion.

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Selection of Sampling Sites - Sampling sites 1, 2, 3, referred to as the 'outside sites' are derived from the opportunistic sample.
Sampling sites, 4, 5, 6, referred to as the 'inside sites', are derived from interviews with the local knowledge experts.

Groundfish Gill Nets Sampling - Marine research sampling design is developed wherein strings of five alternating 51/2" and 6" mesh groundfish gill nets are to be set in each site. Groundfish gill nets are used to reduce bycatch, to reduce the likelihood that sampled hake will vomit stomach contents, and to increase the likelihood of sampling success for the size ranges of hake that harvesters claim to have observed as predating on juvenile lobster. Research assistants are trained in sampling procedures, and in stomach contents description and identification procedures. DFO permits are obtained to allow targeted sampling.

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Sampling Area I (Outside Sites) - GNSBFA recruits captain, crew and boat for sampling. The 1st Phase of sampling is conducted between September 4th and 20th, 2001 on the opportunistically recommended 'outside sites'. A total of 1770 groundfish stomachs (1618 white hake) are gathered and their contents are described.

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Sampling Area II (Inside Sites) - Phase II sampling occurs in July 2002 at the three 'inside sites' recommended by at least three independently interviewed local knowledge experts. 159 white hake stomachs are sampled and their contents described.

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Sampling Area III (All Sites) - Phase III sampling occurs in September 2002. A 41/2" mesh net is added to the strings and all six sites are sampled in rotating cycles. 1417 groundfish stomachs are collected (1316 white hake) and their contents are described.

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Results Analysis and Dissemination - The research design and results are prepared in a preliminary research report and distributed to GNSBFA members and others (SRSF Research Report #7, available at: www.stfx.ca/research/srsf).

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Study Impacts - The research results are presented to and discussed at the March 2003 GNSBFA annual meeting. The research, its results, and various explanations are well received and uncontested by GNSBFA members.

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Further Dissemination - The results are now prepared for submission to academic research journals. The 1st research paper appears in the *Canadian Journal of Fisheries and Aquatic Sciences* in Spring 2004.

Selected Research Results

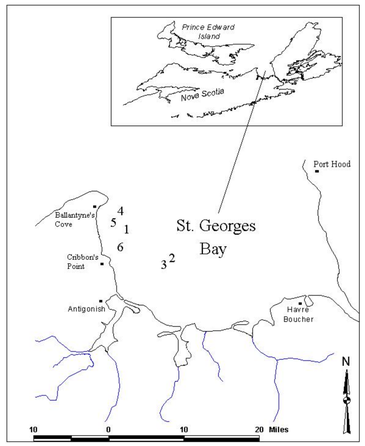


Figure 1. Map of St. Georges Bay showing sites where groundfish were sampled in the three phases.

Table 1: Mean ± 95% confidence interval catch per unit effort (CPUE) and total length of white hake sampled in St. Georges Bay during 2001 and 2002. Means with different superscripts (a,b,c) differed significantly (Sheffe's test, $P < 0.05$). The soak times were not available for six sets during September 2001; hence, these tows were not included in calculating CPUE.

Depth (m)	Date	No. of sets	Number of white hake	CPUE (hake per hr)	Mean length (cm)
30-40	Sept. 2001	36	1618	1.41 ± 0.37^{a}	63.4 ± 0.33^{a}
15-30	July 2002	42	159	0.17 ± 0.05^{b}	60.4 ± 0.97^{b}
30-40	Sept. 2002	15	781	2.72 ± 0.92^{c}	59.8 ± 0.49^{b}
15-30	Sept. 2002	6	535	3.16 ± 2.32^{c}	58.0 ± 0.66^{c}

Figure 2: Length-frequency distributions for white hake captured in St. Georges Bay during September 2001 deep stations (open diamonds), July 2002 shallow stations (open squares), September 2002 deep stations (closed triangles), and September 2002 shallow stations (closed squares). The numbers on the X-axis represent the mid-points of 5-cm length classes.

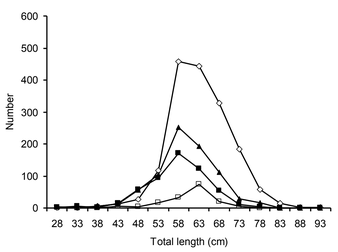
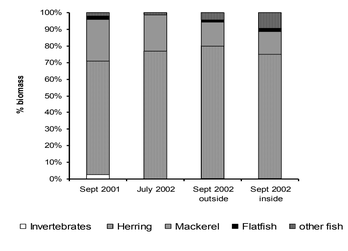


Figure 3: Contribution of various fishes and invertebrates to the diet of white hake in St. Georges Bay, 2001 and 2002. White hake < 45 cm TL were excluded from the analysis.



In a Nutshell

- Social research processes may contribute meaningfully to marine science research designs, thereby demonstrating the necessity and benefits of interdisciplinary collaboration.
- Consulting and incorporating fish harvesters' ecological knowledge contributes to better understandings of marine fish ecology; and enables the exchange of new knowledge between scientists and harvesters.
- Collaborative research, with an inclusive and open process engaging harvesters' concerns, is key to improving working relationships, communication, and research outcomes.
- Collaborative research outcomes potentially contribute to more effective fisheries assessments and management.

Key Findings

- Contrary to expectations of the harvesters, American lobster was not found in any white hake stomachs collected during this study (Figure 3). Pelagic fishes were the dominant prey eaten by white hake > 45 cm TL in St. Georges Bay. Atlantic herring (*Clupea harengus*) was the principal prey (range 68-80% of prey biomass) followed by Atlantic mackerel (*Scomber scombrus*) (range 14-25% of prey biomass).
- However, Axiid shrimp (*Axius serratus*), a species that resembles a small American lobster, were found in four white hake. These *A. serratus* are likely responsible for the harvester's perception of the frequency of occurrence of lobster in hake stomachs.

Juvenile American lobster (*Homarus americanus)*

Axiid shrimp (*Axius serratus*)

- None of the harvesters participating in the association meetings expressed prior knowledge of Axiid shrimp or of the taxonomic differences between *A. serratus* and juvenile American lobster. Furthermore, not one harvester contested the possibility that the observations of *Axius* in white hake stomachs were misinterpreted as juvenile lobster.
- The results, combined with those of previous studies, indicate that white hake are <u>not</u> major predators on juvenile lobster in the sGSL.
- While the content analyses of the white hake stomachs sampled do not support fish harvester's concerns about high levels of predation on juvenile lobster, the fish harvesters' advice respecting the time of year for and location of sampling did produce successful catch results during September (but not during July).
- The systematically selected 'local experts' did specify that sampling should occur in markedly different places, times of year, and water depths than those specified by the 'opportunistically sampled' participants in the roundtable. While the sampling results during the September periods showed general similarities in the catch-per-unit-effort (CPUE) and the size composition of catches between the two depth zones, the CPUE from the LEK 'local expert' sites was higher. Yet, the most disappointing sampling results occurred in July 2002, at the time of year and on sites specified by the systematically selected LEK experts.

Management Implications

- The research demonstrates that consulting and incorporating fish harvesters' ecological knowledge will enhance the design and conduct of studies aimed at exploring the ecology of marine fishes.
- This research has also demonstrated the research design, research outcomes, and dissemination benefits of developing and working within fish harvester organisation, university and government science collaborations.
- On the basis of the similarities and differences in results obtained, the reliability, representativeness, and confidence benefits of systematically designed and conducted social research are essential to both documenting LEK and employing LEK in marine science. Furthermore, LEK documented systematically provides harvesters with the prospect of greater 'voice' in, and engagement with, marine science and resource management.