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Update on effort standardization for the in-season monitoring of the prawn by trap fishery

Bilan de la normalisation de l'effort pour la surveillance en saison de la pêche des crevettes au casier

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Abstract

The prawn trap fishery is managed using an escapement index, referred to as the Spawner Index (SI). The SI was historically developed using fishery independent methods and gear. In-season monitoring of the SI is done using fishery dependent methods and gear. Development and increased use of alternative trap and bait types in the commercial fishery require that correction factors be developed to ensure that the SI is applied correctly. This paper documents experiments to determine catch efficiency of double-ring traps and pellet bait. No significant differences were detected in the catch efficiency of legal-size prawns in double-ring traps versus the standard traps. Catches of legal-size prawns were significantly greater ($p<0.005$) for pellets than standard bait. On average, pellet bait caught 1.27 times more legal-size prawns than the standard bait on which the SI was developed.

Résumé

La pêche des crevettes au casier est gérée en fonction d'un indice d'échappement, appelé indice d'abondance des reproducteurs (IAR). Des méthodes et des engins autres que ceux utilisés pour la pêche ont été utilisés pour le développer. Par contre, la surveillance en saison de l'IAR est effectuée à l'aide de méthodes et d'engins utilisés pour la pêche. La pêche commerciale a connu le développement et l'utilisation accrue d'autres types de casier et d'appât. Il faut donc établir des facteurs de correction afin d'assurer que l'IAR est bien appliqué. Ce rapport documente des expériences visant à déterminer l'efficacité des casiers à deux anneaux et des appâts en boulettes. Aucune différence significative n'a été relevée dans l'efficacité de capture des crevettes de taille réglementaire entre les casiers à deux anneaux et les casiers standards. Les prises de crevettes de cette taille obtenues avec des appâts en boulettes étaient significativement plus fortes ($p < 0,005$) que dans le cas des appâts standards appâts ayant servi à la conception de l'IAR; en moyenne, 1,27 fois plus de crevettes de taille réglementaire ont été capturées lorsque des appâts en boulettes ont été utilisés.

1.0 Introduction

The spot prawn, *Pandalus platyceros*, is the largest of six commercial pandalid shrimp species occurring in waters along the coast of British Columbia. The prawn trap fishery is presently managed using an escapement based model often referred to as the Spawner Index Model (Boutillier and Bond 2000). This is a catch per unit effort (CPUE) model based on ensuring a minimum number of spawners are available at time of egg hatch, which normally occurs around the end of March. The number of spawners is measured using a spawner escapement index (SI) developed by Boutillier (1987). For all months preceding egg hatch minimum monthly indices (MMI) were established through back calculation using an estimated natural mortality rate obtained from research survey studies (Boutillier and Bond 2000).

Implementation of this escapement model is carried out through an in-season industry funded monitoring program. At-sea observers sample a sub-set of the commercial catch at the time fishing gear is retrieved. These samples provide CPUE estimates of the number of prawns per trap by sexual stage. The spawner index model uses the CPUE of only those prawns that would have contributed to the spawning population in March following the fishing season. This component of the catch is largely the legal-size prawns (>33mm carapace length) which are comprised of transitional and female sexual stages. Additional sampling is carried out, by commercial vessels under scientific licence, in the late fall/early winter well after the commercial fishery closes to provide another measure of the SI for comparison to the MMI.

Although the escapement index was developed using fishery independent standardized gear and bait, current monitoring of the SI is done using fishery dependent fishing gear therefore gear standardization studies are imperative. Commercial fishing gear is constantly changing therefore the implementation of this strategy requires ongoing research and evaluation of commercial fishing effort to ensure consistent application of the SI (Boutillier 1985, 1986; Boutillier and Sloan 1987). Correction factors have been implemented over the years to account for the changes in trap type (Boutillier 1988). Two recent changes in the commercial fishery have been: 1) the widespread use of a previously unevaluated trap type; and 2) a shift towards the use of commercially prepared pellet bait specific for prawns.

This paper has been prepared in response to a request to evaluate changes in prawn catch efficiency resulting from the use of a previously unevaluated trap type (which we refer to as a "double-ring" trap) and the use of commercially prepared pellet bait (Appendix 1). In this paper we first present a comparison of prawn catch efficiency of the double-ring trap versus the standard trap on which the SI is based. Secondly we evaluate the prawn catch efficiency of commercially prepared pellet bait to the canned pet food grade tuna bait on which the SI is based. We then present results and propose efficiency ratings to be applied to both trap type and bait type to compensate for differences in efficiency.

2.0 Methods

2.1 Prevalence of double-ring traps and pellet bait

Data on trap type and bait type from the in-season spawner index sampling was used to index annual trends in commercial use. This data was obtained from the "prawntrp" database maintained by the Shellfish Stock Assessment Data Unit. An index of percent prevalence of double-ring traps was simply calculated by dividing the number of double-ring traps by total number of traps sampled within a commercial fishing season. This same method was also used to index prevalence of pellet bait.

2.2 General outline of standardization experiments

Two separate effort standardization experiments were carried out, a trap standardization and a bait standardization experiment. The first experiment compared the catch efficiency of double-ring traps to standard traps on which the spawner index is based. The second effort standardization experiment compared the catch efficiency of commercially prepared pellet bait to canned pet food grade tuna on which the spawner index is based.

2.3 Study site

The trap type standardization and bait standardization experiments were conducted in Howe Sound, Pacific Fishery Management Area 28 (Fig. 1). The trap experiment spanned 2 time periods; October 22-30, 2002, and February 25-March 5, 2003. The bait type standardization experiment also spanned two time periods; October 29 – November 5, 2003 and February 12-19, 2004.

2.4 Gear specifications

For the trap type standardization experiment two trap types were used. The standard control traps were designed by SAK Industries and a truncated cone nesting design with the frames constructed of stainless steel rings. The bottom ring measures 77 cm in diameter, middle ring 72 cm and top ring 66 cm in diameter with and overall height of 31 cm covered in 3.8 cm stretched web with three tunnels. The commercial trap evaluated in this study for prawn catch efficiency was similar in design to the standard trap except for the addition of a second bottom ring located approximately 3 cm above the base ring. All traps were baited with pet food grade tuna.

For the bait effort standardization experiment two bait types were used. The standard bait type was a 26 g can of pet food grade tuna. The experimental bait type was commercially prepared pellet bait for prawns. Only one trap type was used in this experiment, the standard SAK Conical Nesting trap described above. We refer to traps baited with pet food grade tuna as the standard or control traps, and traps baited with pellet bait as experimental traps. For the control traps each can of pet food grade tuna was punctured with four 5 mm size holes on one surface of the can to allow access to bait.

One can was suspended in the middle of each of the traps. The experimental traps utilized 500 ml bait cups filled 3/4 full with pellet bait. These were also suspended in the middle of the trap equal distance from the entrance tunnels.

2.5 Gear deployment

For the trap type effort standardization experiment 20 traps were fished on a single 380m ground line. Traps were spaced at 20m intervals similar to spacing in the commercial fishery. Each ground line (set) consisted of 10 traps of each type alternated at equal distance from each other along the length of the ground line. Each set was soaked overnight for 15-24 hours. A total of 17 sets were deployed for the trap efficiency experiment.

For the bait type effort standardization experiment 20 traps were fished on a single 380 M ground line. Traps were spaced at 20m intervals similar to spacing in the commercial fishery. Each ground line consisted of 10 traps of each bait type alternated at equal distance from each other along the length of the ground line. Each set was soaked overnight for 15-24 hours. A total of 15 sets were deployed for the bait efficiency experiment. All sets were deployed from the fisheries research vessel CCGS Neocaligus.

2.6 Data collection and analysis

The data collection procedures and analysis were similar for both the trap and bait standardization experiments. For each individual trap hauled to the surface the number of prawns captured was recorded by sex stage. Sexual stage was determined using external morphological features described by Butler (1980). Total weight by sex for each trap type or bait type (dependent on the experiment) on a string was recorded along with individual carapace length measurements. Sex was recorded as male, transitional, female, ovigerous female, or spent female. All by-catch was separated to species, pooled by string and total weight recorded.

The seasonal timing of the standardization experiments occurred much later in the year than the commercial fishery as a result legal-size prawns captured in the standardization experiments were comprised of two different spawning cohorts. Nevertheless, we were concerned with standardizing effort to the commercial fishery so the catch of legal-size prawns was used in the standardization analysis. Accordingly the following computations were carried out:

Average catch of legal-size prawns per trap, by trap type or bait type (depending on the experiment), on a string was calculated as follows:

$$\bar{x} = \sum c / n$$

where

c = legal-size prawn catch per trap
n = number of traps

Pairwise t-tests were employed to test the null hypotheses for both the trap type and bait type experiments. For the trap type experiment 17 paired samples were used in the analysis and for the bait type experiment 15 paired samples were used. All computations were done using Systat (Systat Software Inc).

An efficiency or correction factor was determined using a simple ratio estimator as follows:

$$r = \sum_{i=1}^{n} E_i \Big/ \sum_{i=1}^{n} S_i$$

where

E_i = average catch of legal-size prawns per trap in experimental traps for string i
S_i = average catch of legal-size prawns per trap in standard traps for string i
n = number of strings

3.0 Results

3.1 Trends in the prevalence of double-ring traps and pellet bait use

Double-ring traps were first recorded in the commercial prawn fishery in 1997 and have increased in use up to 2002 where 21% of the in-season spawner index samples were obtained from double-ring traps (Table 1). The use of pellet bait has increased from 1990 to 2004 based on in-season sampling. In 1990 only 2% of the in-season spawner index samples were obtained from traps baited with pellet bait. In 2004 95% of the samples were obtained from traps baited with pellet bait (Table 1).

3.2 Trap efficiency

The overall mean catch per trap of legal-size prawns was 21.278 for the double-ring trap and 20.688 for the standard trap (Table 2). Although the double-ring traps caught on average 1.03 times more legal-size prawns than standard traps the difference was not significant ($p>0.600$).

3.3 Bait efficiency

Catches of legal-size prawns in traps using pellet bait was significantly greater ($P<0.005$) than in traps using canned pet food bait. The overall mean catch of legal-size prawns was 26.79 and 21.15 for the pellet bait and canned tuna respectively (Table 3). The pellet bait caught on average 1.27 times more legal-size prawns than the canned tuna (Table 3).

4.0 Discussion

The efficiency of the double-ring traps did not differ significantly from that of the standard traps. This result is a little surprising since there has been an increasing use of double-ring traps since the mid 1990's. Factors other than increasing catch efficiency must be influencing the use of double-ring traps. Although the double-ring trap tested in this study was determined to be equal to the efficiency of the standard trap it is important to note that other trap designs have been tested in previous studies and not all are equal in efficiency to the standard trap (Boutillier 1988).

The effect of bait type on catch efficiency has not been previously evaluated as it relates to the prawn trap fishery. The results of this study indicate that bait type can be a significant factor affecting catch efficiency. The efficiency rating determined through this study may be an underestimate of what is occurring in the commercial fishery. Some fishers are now augmenting the commercially prepared pellets with fish oil in an effort to increase bait efficiency and thus catch rates. Further evaluation of bait efficiency should be undertaken to ensure effort standardization.

One of the implications of instituting an efficiency rating to bait type is that it will interact with the existing trap efficiency ratings. Trap type and bait type corrections may not be additive or multiplicative due to factors such as trap saturation and spatial limits on distance from traps that prawns are "attracted". To address this issue is problematic in that it is simply not feasible to test every trap/bait combination in use in the commercial fishery. A suggested approach to this problem is to continue to implement existing efficiency ratings for trap type and for the short term implement a bait efficiency rating, then carry out standardization studies that evaluate the standard against trap/bait type combination as opportunities permit. Efficiency ratings can then be refined for trap/bait combinations.

To ensure a consistent application of the spawner index model any changes in prawn catch efficiency need to be accounted for. Changes in catch efficiency, as a result of design modifications to prawn trap gear, is a recognized issue. Evaluation of various trap designs has been an ongoing part of the assessment program (Boutillier and Bond 1999). Trap efficiency experiments have to be carried out using a tightly controlled experimental design in order to detect and measure changes in efficiency. This information cannot be obtained from analysis of commercial fishing data and requires the continuation of field research programs.

5.0 Recommendations

1. When determining spawner index levels using sampling results from traps using "pellet" bait, the sample index should be divided by 1.27 to ensure standardized application of the spawner index model.

2. Effort standardization studies should continue to be incorporated into the overall prawn assessment program.

6.0 Acknowledgments

Antan Phillips (DFO) helped coordinate and participate in the Howe Sound portion of the study. Alan Young and the crew of the Coast Guard Vessel Neocaligus conducted the trap fishing operations. Jim Morrison and Rob Houtman (DFO) provided formal reviews that improve this paper.

7.0 References

Boutillier, J.A. 1985. Important variables in the definition of effective fishing effort in the trap fishery for the British Columbia prawn *Pandalus platyceros* Brant. J. Shellfish Res. Vol. 5(1): p. 13-19

Boutillier, J.A. 1986. Fishing effort standardization in the British Columbia prawn (Pandalus platyceros) trap fishery. P. 176-181. In Assessment and Management of Invertebrates. Can. Spec. Publ. Fish. Aquat. Sci. 92

Boutillier, J.A. 1987. Prawn (trap fishery), In Harbo, R.M., and G.S. Jamieson. [eds.]. Status of invertebrate fisheries off the Pacific coast of Canada (1985/86). Can. Tech. Rep. Fish. Aquat. Sci. 1576. p. 65-72.

Boutillier, J.A. and N.A. Slone. 1987. Effect of trap design and soak time on catches of the British Columbia prawn, Pandalus platyceros. Fish. Res. 6: 69-79.

Boutillier, J.A. 1988. Standardization of effort in the prawn fishery as it relates to biological sampling and escapement management. Pacific Stock Assessment Review Committee Working Paper I88-5.

Boutillier, J.A. and J.A. Bond. 1999. A progress report on the control of growth and recruitment overfishing in the shrimp trap fishery in British Columbia. CSAS Research Document 99/202

Boutillier, J.A. and J.A. Bond. 2000. Using a fixed escapement strategy to control recruitment overfishing in the shrimp trap fishery in British Columbia. J. Northw. Atl. Fish. Sci., Vol.: 27: 261-271.

Butler, T.H. 1980. Shrimps of the Pacific coast of Canada. Can. Bull. Fish. Aquat. Sci. 202: 280 p.

Systat Software Incorporated. 501 Canal Blvd. Suite C. Point Richmond CA, 948040-2028 USA.

Table 1. Prevalence, by year, of double-ring trap and pellet bait use as determined from in-season spawner index sampling.

	Prevalence (%)	
Year	Double Ring Traps	Pellet Bait
1990	0.0	2.0
1991	0.0	8.0
1992	0.0	10.0
1993	0.0	58.0
1994	0.0	n/a
1995	0.0	79.0
1996	0.0	88.0
1997	3.0	90.0
1998	2.0	92.0
1999	4.0	90.0
2000	6.0	91.0
2001	13.0	93.0
2002	21.0	93.0
2003	15.0	95.0
2004	21.0	95.0

Table 2. Mean catch per trap of legal-size prawns, by string and trap type

Location	Date	Set #	Mean catch per trap	
			Standard	Double Ring
Howe Sound	Oct 22 - 30, 2002	1	24.4	21.5
		2	24.1	20.0
		3	25.0	23.8
		4	31.4	40.3
		5	20.2	21.3
		6	29.2	16.2
		7	23.1	19.9
		8	16.8	8.7
Howe Sound	Feb 25 - Mar 5, 2003	9	22.1	21.0
		10	19.2	26.1
		11	9.9	14.5
		12	22.5	21.5
		13	10.5	11.3
		14	17.0	25.5
		15	24.2	25.8
		16	22.6	31.8
		17	9.5	12.5

Table 3. Mean catch per trap of legal-size prawns, by string and bait type

Location	Date	Set #	Mean catch per trap	
			Canned Tuna	Pellets
Howe Sound	Oct 29 - Nov 5, 2003	1	25.4	38.5
		2	13.6	19.6
		3	42.3	47.7
		4	33.5	35.3
		5	12.2	12.2
		6	8.6	6.4
		7	18.0	23.1
Howe Sound	Feb 12 - 19, 2004	8	18.1	22.0
		9	24.5	39.6
		10	17.8	21.7
		11	7.9	8.2
		12	21.2	21.9
		13	22.0	40.3
		14	24.3	34.0
		15	27.9	31.3

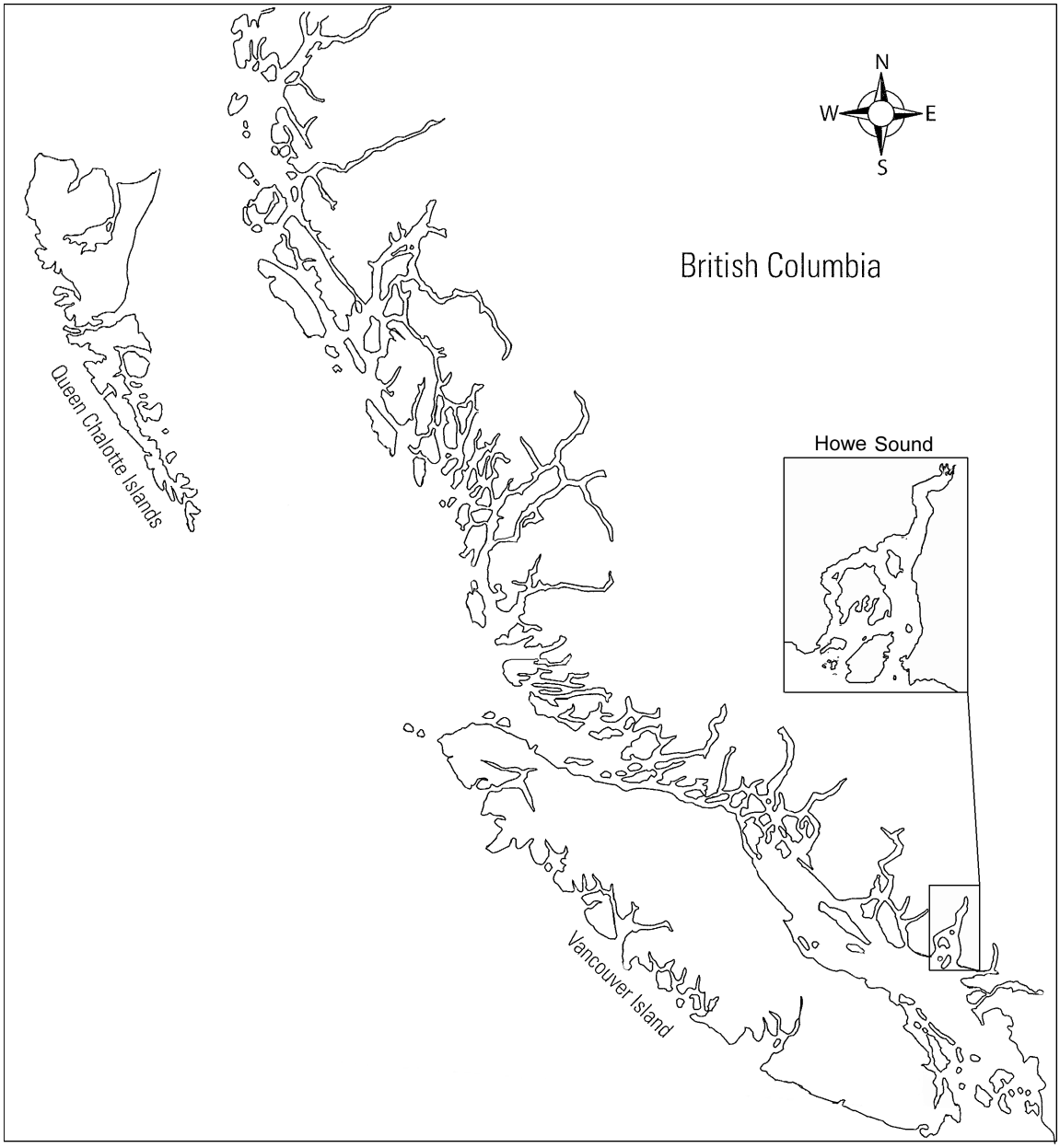

Figure 1. Map of the British Columbia coast showing location of Howe Sound.

Appendix 1. Request for Working Paper

PSARC Request for Working Paper

Date Submitted: February 2004

Individual or group requesting advice:
(Fisheries Manager/Biologist, Science, SWG, PSARC, Industry, Other stakeholder etc.)
Fisheries Management and Science

Proposed PSARC Presentation Date: June, 2004

Subject of Paper (title if developed):
Subject - Evaluation of prawn catch efficiency change in the commercial fishery due to trap and bait type and its implication on the spawner index reference point model.
Title – Update on effort standardization for the in-season monitoring of the prawn by trap fishery
Science Lead Author: Dennis Rutherford

Resource Management Lead Author:

Rationale for request:
(What is the issue, what will it address, importance, etc.)
Prawn stock strength is measured using a spawner index. This spawner index is monitored in-season through sex specific CPUE sampling on board commercial fishing vessels. The index is based on a "standardized" gear configuration. The commercial prawn trap fishery continually adopts new fishing gear configuration in an effort to increase production. Recent advancements in trap design and bait type are in wide use in the commercial fishery. The catch efficiency of this new gear needs to be evaluated relative to the "standardized" gear to ensure appropriate implementation of the spawner index management and assessment tool.

Objective of Working Paper:
(To be developed by FM, StAD, Habitat Science, HEB/Oceans for internal papers)
Determine if the catch efficiency of trap gear has changed as a result of trap design changes and use of pellet bait.

Question(s) to be addressed in the Working Paper:
(To be developed by initiator)

Do the "double ring" traps widely used by industry have the same catch efficiency as the "standardized" trap on which spawner indices are based?

Does "pellet" bait increase catch efficiency relative to the "standard" bait type?

Does an efficiency rating or correction need to be applied to "double" ring traps and "pellet" bait when calculating spawner indices from this gear type?

Stakeholders Affected:
Commercial prawn fishers

How Advice May Impact the Development of a Fishing Plan:

If there is an increased efficiency of new bait types demonstrated by this paper, development of an correction factor for bait will have an influence on in-season management of the prawn fishery. In-coming estimates of female and transitional prawn abundance will be reduced by application of the correction factor, potentially resulting in earlier closures in the fishery. The overall management strategy based on the spawner index does not change. Consequently, fishing plan changes are limited to a description of how improved baits may have contributed to the increased catch efficiency demonstrated by the fleet in recent years, and to note that the correction factor will influence analysis leading to closure decisions.

Timing Issues Related to When Advice is Necessary:

The paper will be delivered in June. 45 day revision period - so, it will likely not be formally adopted until the end of this season's fishery. However, if preliminary analysis suggests that there is a significant increase in efficiency, this impact will be of concern for the 2004 fishery. Managers should be advised as soon as possible (prior to or during the 2004 fishery) of any preliminary indication of significant increases in efficiency so that this information can be considered in the in-season decision making process. Managers have commented that they can probably do this by generally being more conservative this year in anticipation of conclusions that may be developed in the paper.

Approved:

Science Manager: _____; Date:_____

Fisheries/Habitat/Oceans
Manager: _____