J. Northw. Atl. Fish. Sci., Vol. 6: 173–175

LETTERS TO THE EDITOR

Comments on Paper by Brêthes *et al.* (1985)

Fishery biologists like to use catch per trap as an index of crab abundance because data can be obtained from a fishery or from research vessel surveys at relatively low cost. The alternatives of direct animal counts by divers, by remote photography/video, or from submersibles are expensive and may be impractical for some habitats. The assumptions of indirect methods, such as tag-recapture and Leslie, are difficult to meet and biased results are common. However, the conversion of catch-per-trap data to absolute population density involves calibration of area of bottom fished by a trap, and this requires use of expensive or questionable methods. Brêthes *et al.* (1985) calculated the area of influence and effective area fished for baited crab traps by using a modification of the Leslie and tag-recapture methods. I believe that some of their conclusions are not supported by their results.

A trap's area of influence was defined as a circle with a radius equal to the limit of detection of bait odor by the target species. In the field, tagged snow crabs (*Chionoecetes opilio*) were released in a line at various distances from each of 22 traps. To calculate the radius of detection, the percentages of recaptures were plotted against release distances and a regression line extrapolated to the distance axis, i.e. at zero recaptures. This procedure gave a radius of detection of 106 m, which appears to be an underestimate. Only recaptures from the trap associated with a line of releases were included in the regression. Mean distances travelled to these traps were 31 m after 24 hr and 38 m after 48 hr. However, 68% of the recaptures were not included in the analysis because they were from traps associated with other lines of releases. Mean distances travelled to these traps were 530 m after 24 hr and 590 m after 48 hr.

Support provided for a correlation between percentage recaptures and distance of release from a trap was not strong. As mentioned above, 68% of recaptures were excluded from this analysis. Recapture rates during 48 hr were not correlated with distance of release. Recaptures during 24 hr were correlated ($r = 0.78$), but this correlation would have been lower, and perhaps not significant, if recaptures in individual traps rather than sample means of 11 traps had been used.

Current direction was not measured but would affect a trap's area of influence. Ebb and flow tidal currents would almost certainly cause the bait odor plume, and consequently the area of influence, to be an ellipse rather than a circle. If tagged crabs were released in a line perpendicular to the current flow, the distance of attraction would be less than if they were released in a line downstream of a trap. If the crabs were released upstream from a trap, they would not be exposed to the bait odor and would possibly disperse before the current direction changed.

Because handling associated with releasing crabs has an unknown effect on their response to bait odor, and because of the importance of current, the method employed for determining a trap's area of influence was not optimum. Even if area of influence could be determined accurately, it has an unknown relationship to the effective area fished, the statistic needed for trap calibration. A frequency distribution of distances travelled for all recaptures would have been an interesting summary of crab movements. The means appear to be 120 m after 1 day, 370 m after 2 days, and 2,350 m after 3 or more days.

Effective area fished was variously defined as a circle in which all crabs have the same catch probability, a circle in which all crabs have a catch probability of one, a circle with a radius one-half the radius of a trap's area of influence, and the ratio of crabs per trap/crabs per square meter. Effective area fished was estimated by using the last two definitions. One-half the radius of a trap's area of influence was 53 m, but I am unable to give a biological interpretation of this result or to relate it to the other definitions of effective area fished.

For catch per trap/crab density, crab density was estimated by a tag-recapture method. The study area was 5.1 km^2, and tagged crabs were released throughout the area. With an average distance moved between release and recapture of about 1 km, a significant number of tagged crabs would have left the area, biasing high the calculated crab density and low the effective area fished. Possible bias from unequal probability of capture of tagged and untagged crabs was mentioned by the authors.

Brêthes *et al.* (1985) noted that the maximum distances which the crabs travelled in their study, 800 m after 1 day and 3,000 m after 2 days, leads to the belief that the area of influence of a trap is much greater than may be surmised from the results of Miller (1975). The latter paper gave results for effective area fished, defined as catch per trap/crab density, where density was determined with bottom photography. I know of no method to relate size (or shape) of a trap's area of influence to the measurements of effective area fished.

Obtaining acceptable estimates of decapod abundance from trap catches is difficult, as illustrated in excellent studies by Morgan (1974) and Morrissy and Caputi (1981). If good calibrations of effective area fished are possible, they probably require a direct count of animal abundance.

BRÊTHES, J.-C, R. BOUCHARD, and G. DESROSIERS. 1985. Determination of the area prospected by a baited trap from a tagging and recapture experiment with snow crabs (*Chionoecetes opilio*). *J. Northw. Atl. Fish. Sci.*, **6**: 37-42.

MILLER, R. J. 1975. Density of the commercial spider crab, *Chionoecetes opilio*, and calibration of effective area fished per trap using bottom photography. *J. Fish. Res. Board Can.*, **32**: 761-768.

MORGAN, G. R. 1974. Aspects of the population dynamics of the western rock lobster, *Panulirus cygnus* George. I. Estimation of population density. *Aust. J. Mar. Freshwat. Res.*, **25**: 235-248.

MORRISSY, N. M., and N. CAPUTI. 1981. Use of catchability equations for population estimation of marron, *Cherex tenuimanus* (Smith) (Decapoda, Parastacidae). *Aust. J. Mar. Freshwat. Res.*, **32**: 213-225.

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Response to Comments of R. J. Miller

In the foregoing letter, Dr R. J. Miller has expressed some scepticism about our study of snow crabs (Brêthes *et al.*, 1985), and some clarification seems to be necessary.

Dr Miller wonders why we did not include crabs which had moved to traps other than their "own" in our analysis, as 68% of the crabs were recaptured in traps that were not associated with their release points. For the purpose of the particular study, there appeared to be no reason to consider together, in the regression analysis, all crabs which had spent 1 to 5 days of freedom. For the 24-hr experiment, we omitted only four crabs (19%) from the analysis but mentioned their travel distances in the results. They were not included because the distances of travel from their points of release to other traps could not be determined as precisely as the distances travelled by those crabs which were recaptured in their "own" traps.

A more important point is the effect of currents. It is obvious that a bias was introduced in our study by neglecting currents and considering the odor plume and the prospected area as circular. However, current direction and intensity are often not known, and a circular area is commonly assumed (Miller, 1975; Eggers *et al.*, 1982). As far as we know, only Gros and Santarelli (1986), using a method derived from Eggers *et al.* (1982), have included current in the calculation of the area prospected by a baited trap in use in a whelk fishery. A current meter was placed in the study area during our experiments, and the data are now available. From comparison of the frequency distributions of the directions followed by crabs and the directions of currents (Fig. 1), we note that the southeastly (ebb tide) current (100-150°) seemed to have an effect but that it did not noticeably influence the recapture rate.

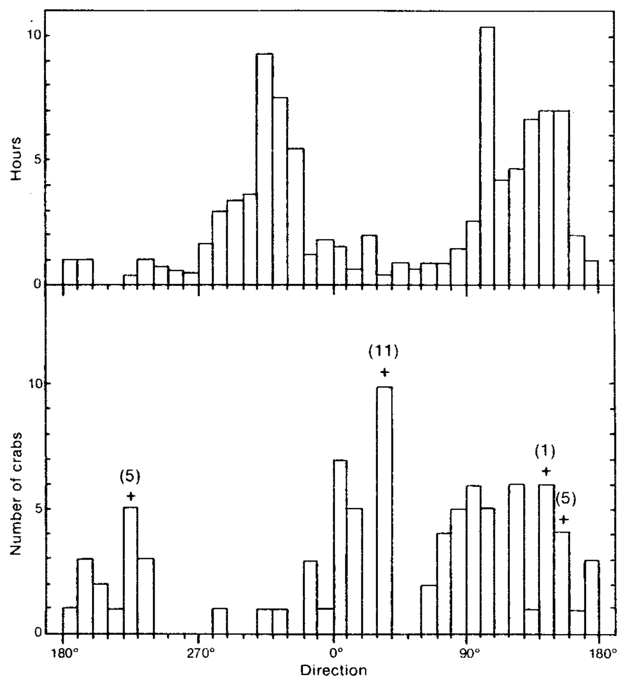

Fig. 1. Frequency distributions of current direction (hours) and crab movement direction (numbers of crabs) observed in the Bay of Malbaie during the October 1983 tagging and recapture experiment. (Directions of the releasing lines from the trap (+) and the numbers of lines () are indicated in the lower panels.)

In fact, it is probable that the effect of currents on the odor plume is modified considerably near the bottom, and, therefore, the resulting shape of the odor plume may be very different from a circle or even an ellipse. Another problem is the coincidence of a particular current regime with the feeding period of crabs, which seems to occur during a few hours at night (Brêthes *et al.*, 1984), i.e. less than a complete tidal cycle.

Miller also criticized the measurement of crab density from the tag-recapture experiment. Actually, we used the Schnabel method and not the Leslie method which was mentioned in his comments. Because the study area had no physical boundaries, exchanges with surrounding areas are possible. Some crabs may have left the study area, but others may have entered the area in view of the large concentration of bait during the experiment. This may explain the coherence of the results.

Previous researchers have considered the effective fished area to be the surface where all animals have an equal probability of being captured. We estimated this effective area from the influencial area by calculating the surface area of a rectangle equal to the surface under the observed curve of decreasing recapture rate. One side of the rectangle was set equal to the maximum rate (P_{max} in the paper) in order to calculate the lower limit of the area. Because the curve was a straight line in our results, the other side of the rectangle was simply $D_{max}/2$. This approach is purely mathematical, but it appears to give good results. Its principle is very close to the basic assumptions of the techniques used by Miller (1975) and Eggers *et al.* (1982).

As a final consideration, Miller's comments do not solve the principal problem. In order to calibrate a baited trap, the scientist may use Miller's (1975) technique by calculating the ratio of mean catch to animal density. In that case, he assumes (i) that the area is circular and (ii) that all animals present are liable to be caught (capture probability equal to unity) without considering the problem of measuring the density. If the scientist uses the technique of Eggers *et al.* (1982) by measuring the overlap between two consecutive devices, he assumes that all animals have the same probability of capture (not necessarily equal to unity) in the area of influence. If he integrates currents in the calculation, as Gros and Sandarelli (1986) have done, the two biases are eliminated. Unfortunately, this method is not possible with every type of gear, as is the case for the snow crab fishery. Our experiment was expected to provide some insight about the question of capture probability and the kind of variability that might be observed. In our opinion, the major bias of our experiment was associated with the releasing technique, in that the bags that were used did not permit easy escapement of crabs and thus limited their subsequent movement. Certainly, this was part of the reason for the low recapture rate. As we stated in the paper, the technique can be improved. In view of the various biases associated with the experiment, we did not place too much emphasis on the numerical results which "must be considered as gross approximation".

We agree with Miller's comment that calibration of baited gear is difficult. The choice of a technique depends on the available resources of the researcher in terms of equipment, gear and species to be studied. None of the techniques give satisfactory results. The main conclusion of our study was that the complexity of the problems and the present state of knowledge permit only relative estimates and thus limits the use of baited traps to measure the actual biomass.

BRÊTHES, J.-C, R. BOUCHARD, and G. DESROSIERS. 1985. Determination of the area prospected by a baited trap from a tagging and recapture experiment with snow crabs (*Chionoecetes opilio*). *J. Northw. Atl. Fish. Sci.*, **6**: 37–42.

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MILLER, R. J. 1975. Density of the commercial spider crab, *Chionoecetes opilio*, and calibration of effective area fished per trap using bottom photography. *J. Fish. Res. Board Can.*, **32**: 761–768.

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NOTICE

Recent Advances in Understanding Recruitment in Marine Fishes of the Northwest Atlantic with Particular Emphasis on Georges Bank Herring and Flemish Cap Cod and Redfish Stocks

Special Session of the Scientific Council on Recruitment Studies
Dartmouth, Nova Scotia, Canada, 3-5 September 1986

Specific Topics

1. Brief synopsis of research to date and current knowledge of recruitment process for selected stocks (one invited paper for each region)

2. Evaluation of sampling methods with major focus on first year life stages
   a) Sampling designs, gear and its efficiency relative to behavior
   b) Methods of collection and processing samples, measurement conventions
   c) Ageing methods and their accuracy

3. Estimation of key biological aspects of the recruitment process (focus on interannual variations)
   a) Fecundity and spawning
   b) Distribution and dispersal (eggs, larvae, juveniles)
   c) Abundance at age/size (accuracy of growth and mortality rates)
   d) Recruitment and spawning stock estimates and their accuracy

4. Examination of recruitment variability *vs* potential controlling factors
   a) Patterns of physical environment *vs* spawning and recruitment events
   b) Possible biological factors (time series recruitment *vs* food, predators, spawning stock, disease, parasites)

5. Critique of hypotheses on factors controlling recruitment variability and implications for future research.

Deadlines

Authors are requested to send titles and brief descriptions of their potential contribution to the Convener by **1 March 1986**. Papers will be selected on the basis of their relevance to the topics indicated above. Authors of selected contributions will be informed by **15 April 1986**.

Completed manuscripts (typescript or good quality photocopy) must arrive at the NAFO Secretariat for mimeographing by **20 August 1986**, addressed to Assistant Executive Secretary, Northwest Atlantic Fisheries Organization, Bedford Institute of Oceanography, P. O. Box 638, Dartmouth, Nova Scotia, Canada, B2Y 3Y9.

Publication

Publication in the *Journal of Northwest Atlantic Fishery Science* or *NAFO Scientific Council Studies* will depend on the nature and quality of individual contributions.

Convener

Further information may be obtained from the NAFO Secretariat or from the **Convener**:

Dr M. D. Grosslein
Northeast Fisheries Center
National Marine Fisheries Service
Woods Hole, Massachusetts 02543, USA

Telex: 00-322200
Telephone No.: (617) 548-5123

J. Northw. Atl. Fish. Sci., Vol. 6: 179

NOTICE

Biology of Demersal Resources of the North Atlantic Continental Slopes, with Emphasis on Greenland Halibut and Grenadiers

Special Session in September 1987

This theme was chosen by the Scientific Council of NAFO for a 3-day session in advance of the 1987 Annual Meeting. Details of organizational arrangements, including time and place, outline of topics to be covered, and deadlines for the submission of abstracts and completed manuscripts will be finalized at the September 1986 Meeting of the Scientific Council.

Information for Authors in Preparing Manuscripts for NAFO Scientific Publications

General Guidelines

The manuscript should be typed in English on white paper, preferably 21.5 × 28 cm(8.5 × 11 in.), on one side only. All typing should be double-spaced with at least 2.5 cm margins around the page. Avoid breaking words at the end of lines. Number all pages, including the title page, consecutively with arabic numbers in the center of the top margin. The sequence of the material should be: title page, abstract, text, references, tables, captions for figures, and figures.

Content of Manuscript

Title page

This page should contain the title, followed by the name(s) and address(es) of the author(s) including professional affiliation, and any related footnotes. Limit the title to what is documented in the manuscript, and keep it as concise as possible.

Abstract

An informative abstract must be provided, which does not exceed one double-spaced page or about 250 words, the ultimate length being dependent on the size of the manuscript. The abstract should concisely indicate the content and emphasis of the paper. It should begin with the main conclusion from the study and be supported by statements of relevant findings. It is important that the abstract accurately reflect the paper's contents, because it is often separated from the main body of the paper by abstracting and indexing services.

Text

In general, the text should be organized into Introduction, Materials and Methods, Results, Discussion, Acknowledgements and References. Authors should be guided by the organization of papers that have been published in the NAFO Journal or Studies and by such authorities as the Council of Biological Editors Style Manual (CBE, 9650 Rockville Pike, Bethesda, MD 20814, USA). The Introduction should be limited to the purpose and rationale of the study, with literature review and other information limited to what is needed to define the problem. The Materials and Methods should provide the framework for obtaining answers to the problems which concern the purpose of the study. The Results should answer the questions evolving from the purpose of the study in a comprehensive manner, avoiding any confusion between facts and inferences and the restatment of table and figure captions in the text. The Discussion should give the main contributions from the study, with appropriate interpretaton and comparison with those of other authors. Speculation should be limited to what can be supported with reasonable evidence. In the case of short papers, it is often useful to combine Results and Discussion to avoid repetition. Acknowledgements should be limited to the names of individuals who provided significant scientific and technical support, including reviews, during the preparation of the manuscript, and the names of agencies which provided financial support.

Mathematical equations and formulae must be accurately stated, with clear definitions of the various letters and symbols. If logarithmic expressions are used, the type of function (base 10 or natural logarithms) must be clearly indicated in the text or by appropriate symbols ("$\log_{10}$" or "log" for ordinary logarithms, and "$\log_e$" or "ln" for natural logarithms).

References

Good judgment should be used in the selection of references, which must be restricted largely to significant published literature. References to unpublished data and documents, manuscripts in preparation, and manuscripts submitted to other journals (if not yet accepted for a particular issue) must not be cited in the list of references but may be noted in the text as unpublished data or personal communications (with full mailing address of the authors). Citation of meeting documents which have limited circulation should be avoided whenever possible, except when such documents contain significant new findings for which no other published sources of the information exist.

Literature references cited in the text must be by author's surname and year of publication, e.g. (Collins, 1960). The surnames of two authors may be used in a citation, but, if more than two authors are involved the citation should be (Collins *et al.*, 1960). The citation of mimeographed manuscript reports and meeting documents should contain the abbreviation "MS", e.g. (Collins *et al.*, MS 1960). All papers referred to in the text must be cited in the References alphabetically by the author's surname and initials, followed by the initials and surnames of other authors, year of publication, full title of the paper, name of the periodical, volume and/or number, and range of pages. Abbreviations of periodicals should, if possible, follow the "World List of Aquatic Sciences and Fisheries Serials Titles", published periodically by FAO (Food and Agriculture Organization of the United Nations). References to monographs should, in addition to the author(s), year and title, contain the name and place of the publisher and the number of pages in the volume. Reference to a paper in a book containing a collection of papers should also contain the page range of the paper, name(s) of editor(s), and actual title of the book. The accuracy of all references and their correspondence with text citations is the responsibility of the author.

Tables

All tables must be discussed or mentioned in the text. Tables should be carefully constructed so that the data presented in them are clearly understood and that they fit within either a column or page of the periodical. Each table should start on a separate page and be headed by a description which, together with the column headings, makes the table intelligible with reference to the text. Tables must be numbered consecutively in arabic numericals, which correspond with the order of presentation in the text. The required position of tables in the text should be indicated in the left margin of the relevant page. Place the tables after the list of references.

Figures

Each photograph or drawing, described in the text, must be on a separate sheet in the form of a good quality reproduction and be numbered consecutively with arabic numerals. Lettering should not be overpowering, but should be large enough to withstand reduction of the figure to page width (17 cm) or half-page (single column) width (8 cm). To avoid the use of excessive space, many kinds of illustrations are adequately intelligible if reduced to single-column width, provided that some thought is given to the design and lettering. Black-ink line drawings and/or photographs are acceptable. Over-sized line drawings should be submitted as page-size photographs or good quality photocopies on which the dimensions of the illustrations do not exceed 17 cm wide and 20 cm high, preferably smaller. The original drawings, if larger than 17 × 20 cm, should be retained by the author and forwarded only if requested by the editor or the NAFO Secretariat. The figure number should be clearly indicated on the back or in the bottom margin of each illustration. Figure captions should be typed on a separate sheet which follows the tables in paging sequence. The approximate location of each figure in the text should be indicated in the left margin of the relevant page. A complete set of original or clear illustrations must accompany the original of the manuscript and photocopied sets must be appended to the other copies for review purposes. If the paper contains photographs of animals, organs, tissues, etc., which will not photocopy clearly, a set of such photographs must accompany each copy of the manuscript.

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Manuscript Submission

Journal of Northwest Atlantic Fishery Science

The Journal publishes original research papers and notes on Northwest Atlantic fisheries science with emphasis on the environmental, biological, ecological and fishery aspects of living marine resources and ecosystems. Manuscripts are considered for publication with the understanding that their content is unpublished and is not being submitted elsewhere for publication. Each manuscript is normally reviewed by two referees for appraisal as to its suitability as a primary publication before final evaluation by the editor. Manuscripts (original and **three** copies) should be addressed to:

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Scientific Publications of the Northwest Atlantic Fisheries Organization

Journal of Northwest Atlantic Fishery Science

This publication replaced the ICNAF Research Bulletin which terminated with No. 14 in September 1979. Each annual volume consists of one or more numbers.

Vol. 1 — One number, 10 papers, 112 pages (Published December 1980)
Vol. 2 — One number, 10 papers, 76 pages (Published October 1981)
Vol. 3 — Two numbers, 17 papers, 180 pages (Published May and December 1982)
Vol. 4 — One number, special issue on early stages of marine fishes, 424 pages (Published July 1983)
Vol. 5 — Two numbers, 26 papers, 224 pages (Published January and November 1984)
Vol. 6 — Two numbers, 17 papers, 179 pages (Published June and December 1985

NAFO Scientific Council Studies

This publication replaced ICNAF Special Publication, which terminated with Number 11 (revised) in August 1980, and ICNAF Selected Papers, which terminated with Number 6 in January 1980. One or more numbers are published annually.

No. 1 — Miscellaneous papers (11), 101 pages (Published March 1981)
No. 2 — Manual on groundfish surveys, 56 pages (Published December 1981).
No. 3 — Miscellaneous papers (8), 82 pages (Published April 1982)
No. 4 — Papers on remote-sensing applications to fishery science (12), 98 pages (Published September 1982)
No. 5 — Papers on environmental conditions in 1970-79 (12), 114 pages (Published December 1982)
No. 6 — Miscellaneous papers (8), 104 pages (Published December 1983)
No. 7 — Miscellaneous papers (9), 98 pages (Published August 1984)
No. 8 — Miscellaneous papers (12), 96 pages (Published April 1985)
No. 9 — Papers on squid (17), 182 pages (Published November 1985)

NAFO Scientific Council Reports

This publication (issued annually) replaced ICNAF Redbook which terminated with the issue in December 1979.

1980 — Reports of seven meetings in 1979 and 1980, 190 pages (Published December 1980)
1981 — Reports of four meetings in 1981, 148 pages (Published December 1981)
1982 — Reports of two meetings in 1982, 110 pages (Published December 1982)
1983 — Reports of three meetings in 1983, 152 pages (Published December 1983)
1984 — Reports of three meetings in 1984, 126 pages (Published December 1984)
1985 — Reports of three meetings in 1985, 146 pages (Published in December 1985)

NAFO Statistical Bulletin

This publication (issued annually) replaced ICNAF Statistical Bulletin which terminated with Vol. 28 (revised). The volume numbering continues the series.

Vol. 29— Fishery statistics for 1979, 290 pages (Originally published July 1981; revised edition published November 1984)
Vol. 30— Fishery statistics for 1980, 280 pages (Originally published August 1982; revised edition published October 1984)
Vol. 31— Fishery statistics for 1981, 276 pages (Originally published September 1983; revised edition published March 1985)
Vol. 32— Fishery statistics for 1982, 284 pages (Published December 1984)
Vol.33 — Fishery statistics for 1983, 280 pages (Published December 1985)

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