

Safety in sampling

Methodological notes

Prepared by

Constantine Stamatopoulos

Senior Fishery Data Officer

Fishery Information, Data and Statistics Unit

FAO Fisheries Department

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

All rights reserved. Reproduction and dissemination of material in this information product for educational or other non-commercial purposes are authorized without any prior written permission from the copyright holders provided the source is fully acknowledged. Reproduction of material in this information product for resale or other commercial purposes is prohibited without written permission of the copyright holders. Applications for such permission should be addressed to the Chief, Publishing and Multimedia Service, Information Division, FAO, Viale delle Terme di Caracalla, 00100 Rome, Italy or by email to copyright@fao.org

Preface

Fishery statistical programmes require a great deal of effort and funds for their development and implementation and these are major constraints for many countries with limited human and financial resources. The merit of sampling approaches lies in providing cost-effective and efficient methods for the collection of data, thus accelerating the development of statistics urgently needed by fishery managers and planners.

Collection of basic data on catches, fishing effort and prices constitute a key factor in a wide variety of applications. Sample-based fishery surveys that are conducted on a regular basis constitute an important source of fishery information of wide utility and scope.

To help meet national needs for basic fishery data, FAO has been assisting countries in upgrading their data collection, processing and reporting capabilities. Technical assistance at national and regional level is a significant component of the work programme of FAO's technical units responsible for fishery statistical development and involves both normative and field programme activities. Outputs of normative activities include technical documents on statistical methodology and guidelines for data collection, while field programme activities involve project formulation and implementation, technical backstopping and organization of training courses and workshops.

While the present paper was written with the special concern of sample-based catch/effort assessment surveys for artisanal fisheries, it is envisaged that several of its methodological and utility aspects could be applicable to other types of sample-based fishery surveys, particularly in cases where large-scale data collection programmes operate under financial and personnel constraints. Emphasis is placed on "safety in sampling" and some simple approaches are presented by

means of which statistical indicators regarding sampling accuracy are formulated in advance.

Methodological aspects and statistical indicators that relate to the accuracy and reliability of estimates are presented in handbook form. They summarize experience gained over the recent years in fishery statistical development by the Fishery Information, Data and Statistics Unit (FIDI) of the FAO. The concepts and methods included in the paper apply equally to both marine and inland capture fisheries and are presented in a manner that is generic enough to make them adaptable in commonly used data collection systems.

Readers interested in a more in-depth discussion on statistical and computing approaches, may make use of the list of references that is given at the end of the handbook.

Richard Grainger
Chief, Fishery Information, Data and Statistics Unit (FIDI)
FAO Fisheries Department

Stamatopoulos, C.

Safety in sampling: methodological notes.

FAO Fisheries Technical Paper. No. 454. Rome, FAO. 2004. 91p.

ABSTRACT

The presented methodological notes address the question of sampling accuracy when sample-based data collection operations are performed under operational constraints, a frequent concern of fishery administrations with limited budget and human resources. Such a question is directly related to the frequency and extent of field operations for data collection. The paper focuses on an *a priori* determination of safe sample size using classical statistical methods appropriately adjusted to respond to specific target populations. The concepts and methods included in the paper apply equally to both marine and inland capture fisheries and are presented in a manner that is generic enough to make them adaptable in commonly used data collection systems.

Contents

1. Introduction	1
<i>1.1 Utility of basic fishery data.....</i>	<i>3</i>
<i>1.2 Cost-effective fishery surveys.....</i>	<i>6</i>
2. Concepts in estimating catch and effort.....	9
<i>2.1 A generic formula for estimating catch.....</i>	<i>9</i>
<i>2.2 Target populations and their distributions</i>	<i>12</i>
3. Sampling accuracy.....	15
<i>3.1 Definition</i>	<i>15</i>
<i>3.2 Normalizing the target population.....</i>	<i>16</i>
<i>3.3 Sampling accuracy in normalized populations</i>	<i>16</i>
<i>3.4 Accuracy plots.....</i>	<i>18</i>
<i>3.5 Accuracy and variability.....</i>	<i>19</i>
<i>3.6 Population-specific accuracy boundaries.....</i>	<i>20</i>
4. Global accuracy boundaries	25
<i>4.1 Impact of population density to accuracy.....</i>	<i>25</i>
<i>4.2 Upper limits for variance.....</i>	<i>28</i>
<i>4.3 Accuracy boundaries for concave populations</i>	<i>30</i>
<i>4.4 Accuracy boundaries for convex populations</i>	<i>31</i>

4.5 Exponential form of accuracy boundaries	34
4.6 Critical sample size.....	34
4.7 Accuracy boundaries in infinite populations	37
5. Accuracy boundaries in small populations.....	39
5.1 Example of probabilistic boundaries in small populations.....	39
5.2 Algebraic accuracy boundaries	40
5.3 Properties of algebraic boundaries	43
5.4 Criteria for applying algebraic boundaries	46
6. Applicability aspects of accuracy boundaries	49
6.1 Important questions in sampling.....	49
6.2 Accuracy and precision in sampling	50
6.3 Design phase of a sample survey - guidelines.....	52
6.4 Safe sample size for landings and effort	52
6.5 Stratification and its impact on survey cost	54
6.6 The problem of biased estimates.....	55
6.7 Need for representative samples	56
7. A case study	63
7.1 Estimation of Boat Activity Coefficient (BAC).....	63
7.2 Estimation of CPUE through landings	64
7.3 Emulating “safe” sampling operations	64

8. Diagnostics on accuracy	69
8.1 <i>Estimation process</i>	69
8.2 <i>Basic reporting</i>	70
8.3 <i>System diagnostics</i>	71
9. Discussion	77
9.1 <i>General applicability aspects</i>	77
9.2 <i>Stratification and its impact on sample size</i>	78
9.3 <i>Concluding remark</i>	78
10. Further reading.....	81
Annex A	83
Annex B	87

