ICES
CIEM

Training Course
Introduction to CPUE Standardization
and Development of Annual Indices of
Stock Abundance

ICES INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
CIEM CONSEIL INTERNATIONAL POUR L'EXPLORATION DE LA MER

i   Summary

A course on methods for standardizing catch-per-unit-effort (CPUE) data streams was held at ICES Headquarters in Copenhagen, during 4-8 November 2019. The course, led by Mary Christman (MCC Statistical Consulting and University of Florida, USA) and Shannon Cass-Calay (National Oceanic and Atmospheric Administration/ Southeast Fisheries Science Center, USA), was aimed at individuals involved in the analysis of CPUE time series for their use in fisheries stock assessments and any others with an interest in accurate and precise estimation of standardized time series. The course covered such topics ranging from data preparation, fitting statistical models to data, and interpreting the results. A significant fraction of the course covered an introduction to the statistical methods, model assumptions, data requirements, model development, and diagnostics and remedial measures. The remainder of the course provided an introduction to the software used to develop the statistical models.

ii Training course information

Training course name	Introduction to CPUE Standardization and Development of Annual Indices of Stock Abundance (TCCPUE19)
Dates	4-8 November 2019
Location	Atlantic Room, ICES Headquarters, Copenhagen, Denmark
Instructors	Mary C. Christman, MCC Statistical Consulting and University of Florida, USA
	Shannon Cass-Calay, National Oceanic and Atmospheric Administration/ Southeast Fisheries Science Center, USA

Contents

1   Background

Stock assessments depend on accurate and precise input data (time series of abundance indices and annual catch at length and/or age by species) in order to produce informed advice for best fisheries management. This course covers one of the important inputs to these assessments, namely CPUE time series. CPUE time series should mimic the temporal trends in relative abundance of the stock and standardization ensures that variations in relative abundance are not due to inadequate sampling of stocks or changes in the fishing behaviours of the commercial and recreational fisheries.

Annual indices of stock abundance based on catch and effort data are central to many fisheries' stock assessments. It has become more common in recent years to use advanced statistical methods to standardize catch rates against explanatory variables as a means of adjusting indices for unequal sampling over space or time or habitat. Commonly used methods include general linear models (GLMs), generalized linear mixed models (GLMMs) for non-normally distributed data, delta – lognormal or delta – gamma GLMMs, and generalized additive models (GAMs).

The stocks for which such methods are appropriate include some data-rich stocks where fishery-independent survey data are available to accurately track stock abundance, stocks taken in mixed fisheries (i.e. not targeted) and some data-limited stocks for which fishery-dependent abundance indices provide the main source of information on stock trends. The course will include an introduction to statistical modelling beyond the usual models based on assuming normality of the data, discussion of the effect of sampling strategies on model development and a review of advantages and limitations of standardization. Participants will learn the importance and practical application using real fisheries data examples. All examples will use R: A language and environment for statistical computing (R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/).

2 Context

2.1 Objectives

This course is designed to introduce participants to the most current statistical methods for standardizing catch rates and catch per unit effort against explanatory variables as a means of adjusting abundance indices for unequal distribution of catch locations (and biological catch sampling) and effort over space or time. We will cover several approaches for standardizing estimates of catch per unit effort (CPUE) time series from commercial fisheries, recreational fisheries, and fishery independent monitoring surveys.

At the end of the course, the participants should be able to:

- understand the basic concepts related to standardization methods using model-based approaches;
- identify advantages and disadvantages of model-based standardization;
- learn some approaches for selection of the explanatory variables on which standardization is based;
- identify the role of the sample selection mechanism in a model-based approach;
- identify the distinctions among the various commonly used model forms, including the effect of assuming alternative probability distributions for the catch data;
- perform some model comparisons to identify the "best" fitting model given the data.

2.2 Level

Participants were familiar with current methods for collecting and analysing data by Member Countries for input into stock assessment models. The course was aimed at those participants familiar with general statistical approaches for modelling such as regression, analysis of covariance, and general linear models and the free software platform R and RStudio.

3 Course Programme, Product, Deliverance and Instructors

3.1 Programme

The course featured a full programme over the 5 days. Although not all of the intended topics could be covered in the time available, the presentations and exercises for all of the material were made available to the participants, and some one-to-one discussions towards the end of the week helped to fill in some of the gaps for the attendees.

3.2 Course products

There were no course products.

3.3 Deliverables

There were no course deliverables.

3.4 Course instructors

Mary C. Christman, MCC Statistical Consulting, USA

Shannon Calay, NOAA Fisheries - Southeast Fisheries Science Center, USA

3.5 Recommendations

Update the course in future

Annex 1:   List of participants

Name	Institute	Email
Mary Christman (Instructor)	Department of Biology and of Statistics, University of Florida	marycchristman@gmail.com
Shannon L. Cass-Calay (Instructor)	Sustainable Fisheries Division, NOAA Fisheries - Southeast Fisheries Science Center	shannon.calay@noaa.gov
Andrzej Jaworski	Marine Scotland – Science Scottish Government Marine Laboratory	jaworskia@marlab.ac.uk
Carissa Gervasi Bloom	Florida International University	cgerv002@fiu.edu
Chun Chan	Wageningen Marine Research	chun.chen@wur.nl
Floor Quirijns	Pelagic Freezer-trawler Association (PFA)	fquirijns@pelagicfish.eu
Guillermo Felipe Martin Gonzalez	Irish Marine Institute	guillermo.martin@marine.ie
Hans Gerritsen	Irish Marine Institute	hans.gerritsen@marine.ie
Ioannis Thasitis	Department of Fisheries and Marine Research - Cyprus	ithasitis@dfmr.moa.gov.cy
James Bell (remote)	CEFAS	james.bell@cefas.co.uk
Josefina Teruel Gomez	Instituto Español de Oceanografía Fisheries	josefina.teruel@ieo.es
Julia Wischnewski	Thünen Institute of Sea Fisheries	julia.wischnewski@thuenen.de
Katie Thomas	Irish Marine Institute	katie.thomas@marine.ie
Patrik Börjesson	Institute of Marine Research	patrik.borjesson@slu.se
Rosana Ourens (remote)	CEFAS	rosana.ourens@cefas.co.uk
Sofie Gundersen	Institute of Marine Research	sofie.gundersen@hi.no

Annex 2:   Agenda of topics covered

Topics covered:

(a) Review statistical methods currently implemented in several countries for standardising fishing effort

(b) Using examples, derive abundance indices and associated measures of uncertainty in the index.

(c) Evaluate strengths and weaknesses of the different methods

(d) Discuss filtering methods for selecting trips relevant to single species landed by mixed fisheries (e.g. Stephens and MacCall, 2004, Fisheries Research, 70, 299–310)

(e) Provide guidance on choice of methods for the inputs to stock assessments generally and where relevant specific caveats with regards to use in specific assessment models.

(f) Develop contrasting case studies from ICES EG to demonstrate the application and relative performance of a range of statistical modelling approaches design-based methods of developing relative indices of abundance. This should include some data-rich stocks which also have fishery-independent survey data known to accurately track stock abundance, stocks taken in mixed fisheries (i.e. not targeted) and some data-limited stocks for which fishery-dependent abundance indices could provide the main source of information on stock trends.

(g) Cover abundance indices that could be developed for specific data streams such as on-shore sampling, at-sea-observers and landings & effort information. Where possible, such developments should account for changes in fishery management over time. (e.g. gear restrictions, use of IFQs, etc.)
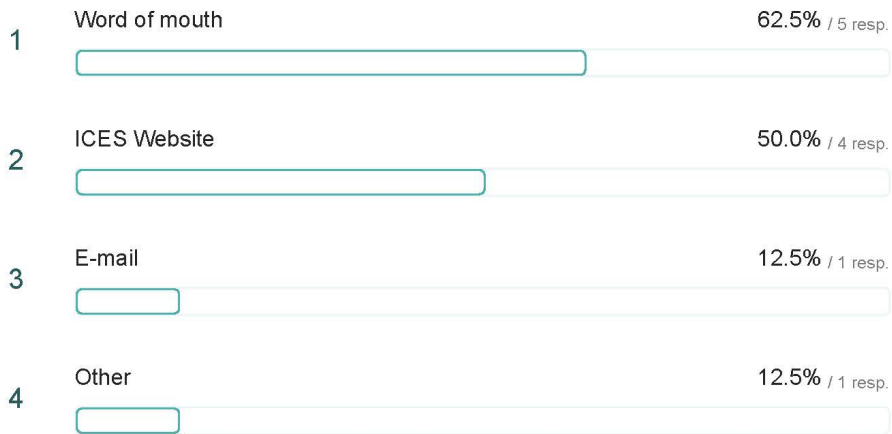
Annex 3:   Results of the survey

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8 responses

How did you hear about this course?

8 out of 8 answered

1	Word of mouth	62.5% / 5 resp.

2	ICES Website	50.0% / 4 resp.

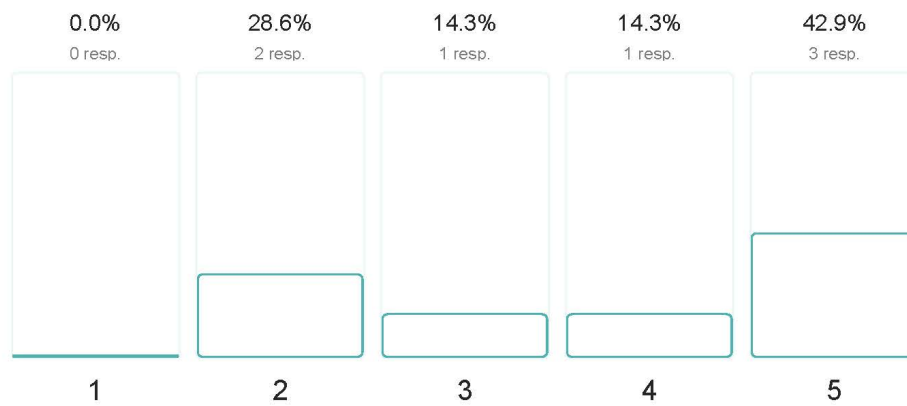| 3	E-mail	12.5% / 1 resp.

4	Other	12.5% / 1 resp.

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Course content
Did the Training course meet your expectations?
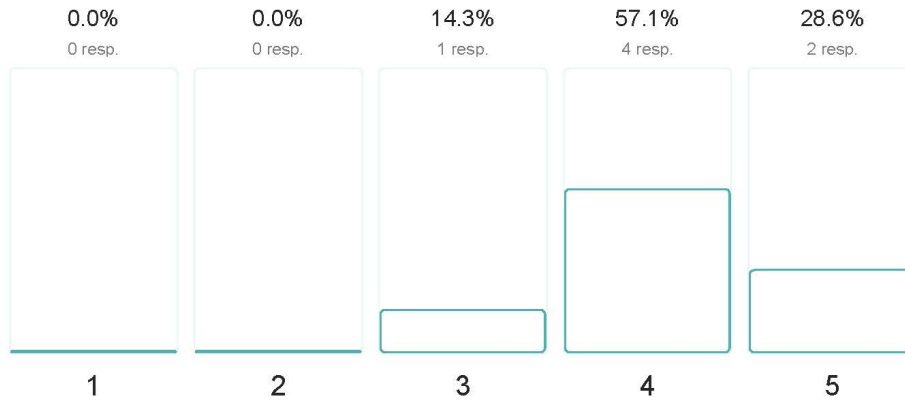
7 out of 8 answered

★ 3.7 Average rating

0.0%	28.6%	14.3%	14.3%	42.9%
0 resp.	2 resp.	1 resp.	1 resp.	3 resp.

| 1 | 2 | 3 | 4 | 5 |

Was the level of instruction appropriate?

7 out of 8 answered

★ 4.1 Average rating

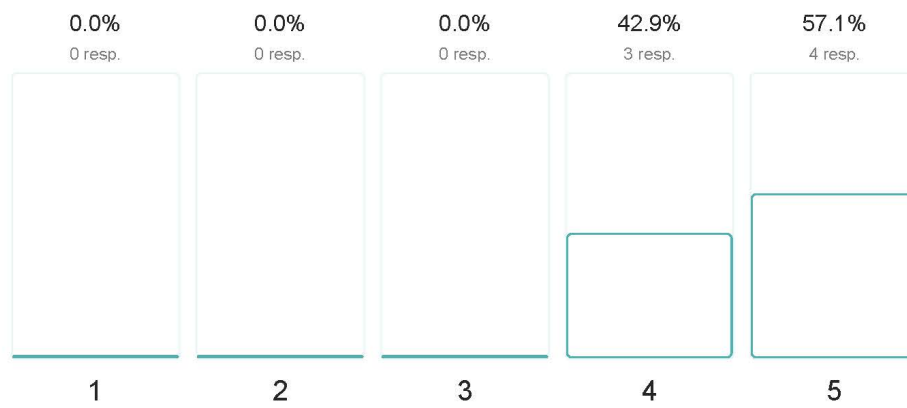| 0.0%	0.0%	14.3%	57.1%	28.6%
0 resp.	0 resp.	1 resp.	4 resp.	2 resp.
1	2	3	4	5

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Was the length of the training course appropriate?

7 out of 8 answered

★ 4.6 Average rating

0.0%	0.0%	0.0%	42.9%	57.1%
0 resp.	0 resp.	0 resp.	3 resp.	4 resp.

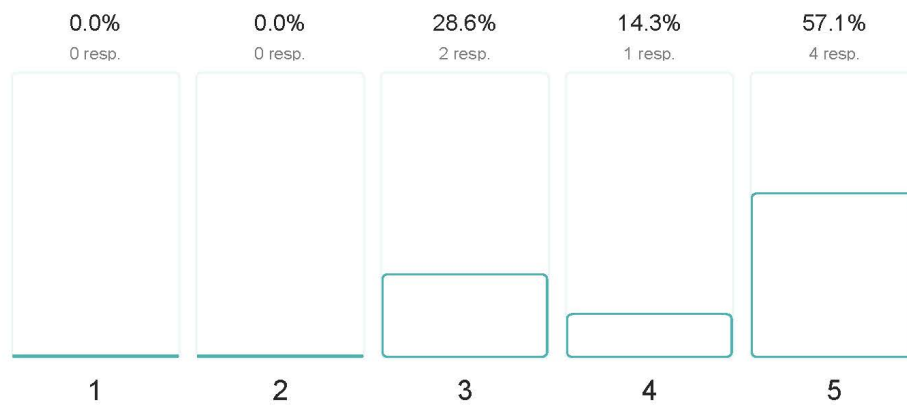| 1	2	3	4	5

Course Organization
Inscription to the training course and communication with organizers were efficient.
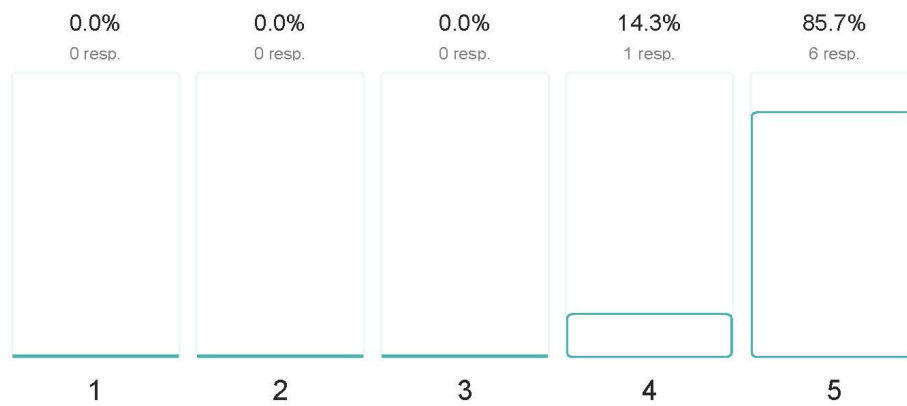
7 out of 8 answered

★ 4.3 Average rating

0.0%	0.0%	28.6%	14.3%	57.1%
0 resp.	0 resp.	2 resp.	1 resp.	4 resp.

| 1 | 2 | 3 | 4 | 5 |

ICES TCCPUE 2019 Survey

Teaching and Learning Support
The instructors were helpful, informative, and approachable.

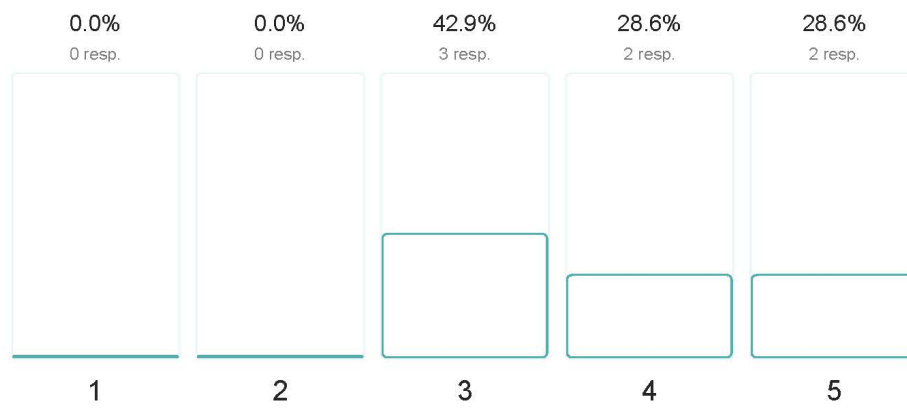**7** out of 8 answered

★ 4.9 Average rating

| 0.0% | 0.0% | 0.0% | 14.3% | 85.7% |
| 0 resp. | 0 resp. | 0 resp. | 1 resp. | 6 resp. |

| 1 | 2 | 3 | 4 | 5 |

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The working documents were presented in a way that facilitated learning.
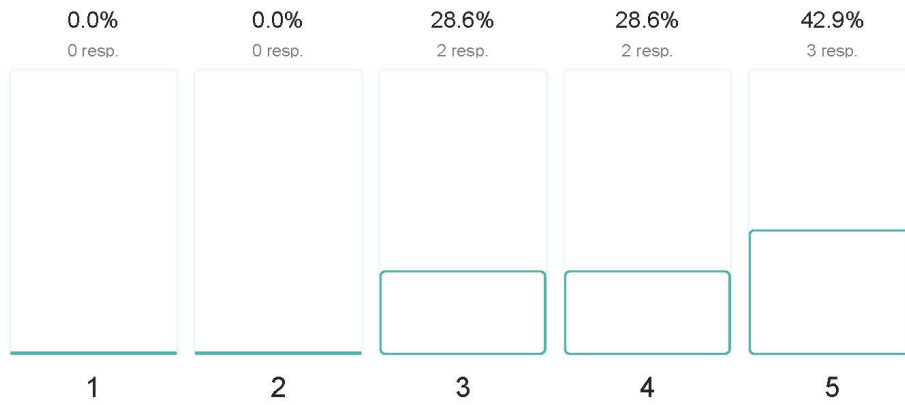
7 out of 8 answered

★ 3.9 Average rating

0.0%	0.0%	42.9%	28.6%	28.6%
0 resp.	0 resp.	3 resp.	2 resp.	2 resp.

| 1 | 2 | 3 | 4 | 5 |

Overall Evaluation
How would you rate this training course?

7 out of 8 answered

★ 4.1 Average rating

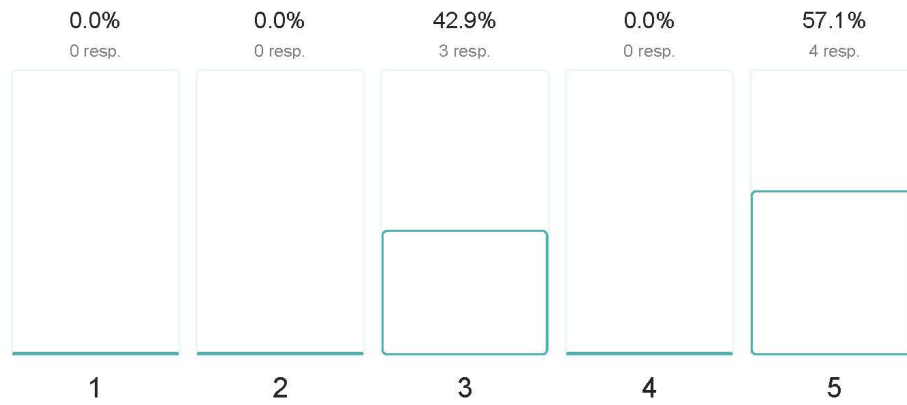| 0.0%	0.0%	28.6%	28.6%	42.9%
0 resp.	0 resp.	2 resp.	2 resp.	3 resp.

| 1 | 2 | 3 | 4 | 5 |

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How would you rate the quality of the teaching?

7 out of 8 answered

★ 4.1 Average rating

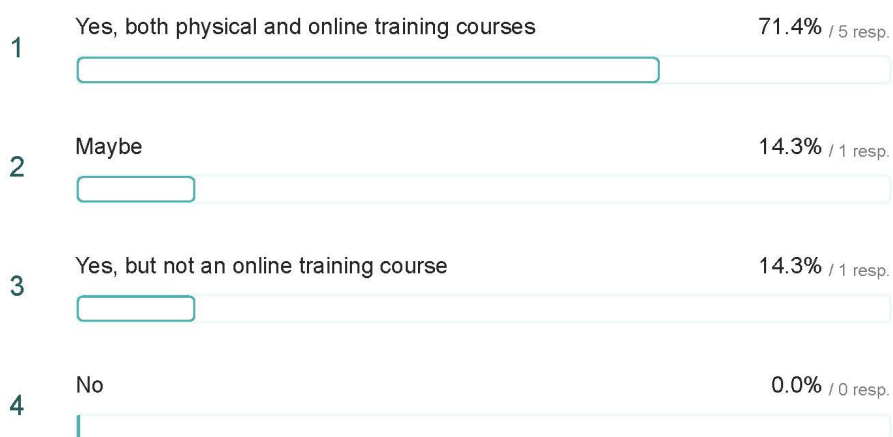| 0.0% | 0.0% | 42.9% | 0.0% | 57.1% |
| 0 resp. | 0 resp. | 3 resp. | 0 resp. | 4 resp. |

| 1 | 2 | 3 | 4 | 5 |

Have you taken any other ICES training courses?

7 out of 8 answered

1 Yes 57.1% / 4 resp.

2 Not with ICES, but I have attended other training courses related to my expertise. 28.6% / 2 resp.

3 No 14.3% / 1 resp.

4 Other 0.0% / 0 resp.
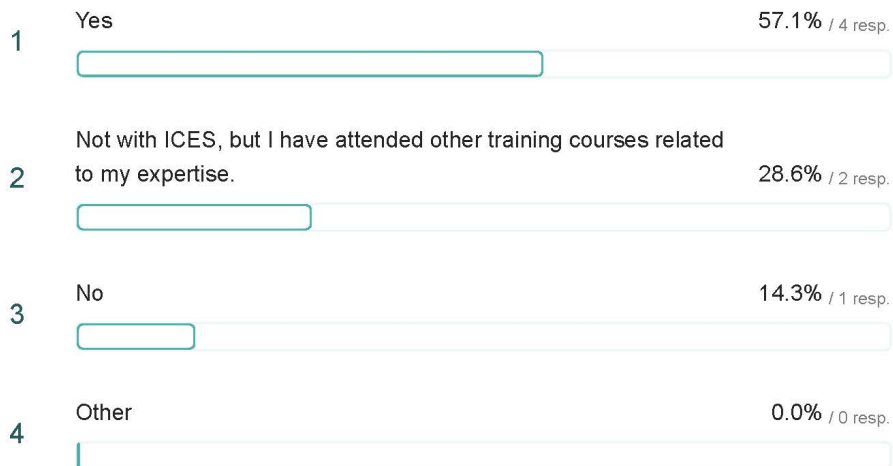
Would you be interested in another training course within ICES?

7 out of 8 answered

1 Yes, both physical and online training courses 71.4% / 5 resp.

2 Maybe 14.3% / 1 resp.

3 Yes, but not an online training course 14.3% / 1 resp.

4 No 0.0% / 0 resp.

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Social Event
Do you feel that you have benefited from networking opportunities on the course?

7 out of 8 answered

1   Yes   100.0% / 7 resp.

2   No   0.0% / 0 resp.

3   Somewhat   0.0% / 0 resp.