

Table 1. Best practices guidelines (Documentation of sampling design, performance of sampling and production of estimates. ICES WGRFS 2013 report.

DOCUMENTATION OF SAMPLING DESIGN, PERFORMANCE OF SAMPLING AND PRODUCTION OF ESTIMATES			
Process that need to be described	Best practice	Comment	Bad practice
Target population	<p>The target population needs to be identified and described.</p> <p>Access to the target population for sampling purposes need to be analysed and documented.</p>	Examples: whole population of resident recreational fishers; fleet of charterboats...	
Primary sampling units (PSUs)	<p>Choice of PSUs should be identified, justified and documented. PSUs could be trips, vessels*time or sites*time (harbours, access points, etc), households, dwellings; individual licensed anglers; residential phonebook listings;</p> <p>PSUs should be documented</p>	If PSU is something else than households, dwellings, residents; trip, vessel or site the choice need to be thoroughly explained.	
Sampling frame	The sampling frame (list of PSUs) should be a complete list of non-overlapping PSUs. The sampling frame should ideally cover the entire target population.	If it is not possible to cover the entire target population with the sampling frame it is good practice to clearly describe how large the excluded part of the population is and the reason for excluding it.	To exclude large parts of the target population in an ad-hoc way.
Stratification of the sampling frame	<p>Strata should be well defined, known in advance and fairly stable. Clear definitions and justifications of strata should be available. One PSU can only be in one stratum. The minimum number of samples within a stratum is dependent on objective, PSU and variance and needs to be calculated. The number of samples within a stratum needs to be justified, in particular if</p>	<p>If the desired minimum number of samples per stratum is not analytically assessed, the choice needs to be justified and described. Care needs to be taken to avoid over-stratification.</p>	<p>To over-stratify (few or no samples in each strata) the sampling schemes. Over-stratification results in increased risk for bias, particularly for ratio estimates, and a need to impute data.</p>

	it is below 10.		
Distribution of sampling effort	<p>The way sampling effort is distributed between strata needs to be described. In accordance with best practice, this can be based on analysis of variance or just distributed proportionally.</p> <p>The different sampling inclusion probabilities/weighting need to be documented.</p>	If other methods, such as expert judgment are used, this should be explained and justified.	
Sample selection procedure	<p>In accordance with good practice, the selection of PSUs to sample should be done in a controlled way allowing for estimation of sampling inclusion probabilities for the different samples. In principal this mean that samples shall be chosen randomly (probability based sampling).</p> <p>Random sampling can be either simple random sampling or systematic random sampling.</p> <p>The selection procedure needs to be justified and described</p>	<p>If it is impossible to use probability-based sampling, the samples need to be thoroughly validated for how representative they are. This process need to be described.</p> <p>If a non-probability based sampling design is applied, this needs to be accounted for in the estimation process (e.g. model based estimations). This needs to be thoroughly explained. For small-scale fisheries where there is no census information on the target population, the only way to sample in accordance with good practice is randomly.</p>	Ad-hoc based sampling, without proper documentation to allow estimation of bias, where the sampling inclusion probabilities cannot be estimated.
Hierarchical structure in the sampling	All the levels in the hierarchical structure of the sampling scheme need to be documented. Sampling should be random at all levels. Sampling probabilities should be worked out at each level, and information for this needs to be collected (e.g. number of boxes)		Failure to account for the different levels of sampling units in the design and estimation processes. (Risk for bias as well as hiding true variation)
Protocol for selection of samples at lower sampling levels (SSU, etc.)	Such protocols should exist in a national repository		

<p>System to monitor performance of sampling schemes - Quality Indicators</p>	<p>Non-response rates should be recorded. Precision of estimates (relative standard error) should be calculated, where relevant. Effective sample size (or appropriate proxy such as number of vessels or trips sampled) should be calculated and recorded.</p>		
<p>Documentation of raising/weighting procedure for national estimates</p>	<p>Data analysis methods should be fully documented, covering: (1) how the stratification and multi-stage sample selection is accounted for in the raising/weighting procedures; (2) ancillary information (for example from national census data; licence registries), that is used to adjust sample weights to correct for any imbalance in samples compared to the population; (3) methods of adjustment for missing data and non-responses.</p>		
<p>Validation/diagnostics</p>	<p>E.g., Independent checks of self-reported data and questionnaires; check trip reports with dealer reports;</p>		

Example of a filled in questionnaire for Recreational Fisheries National surveys evaluation

DESIGN			
QUESTION		ANSWER	COMMENTS (INCLUDING MAGNITUDE AND DIRECTION OF BIAS)
Target population	Are all sectors contribution to the total catch, harvest or release well-known and documented?	Yes / No / Unknown	
	Is there illegal/tourist fishery, which is not accounted for?	Yes / No / Unknown	
	Are there elements of the target population that are not accessible?	Yes / No / Unknown	
Target frame	Is the PSU identified and documented?	Yes / No / Unknown	
	Does the sampling frame fully cover the target population?	Yes / No / Unknown	
	Are there elements of the target population that are excluded from the frame (e.g. non-residents, private access sites)?	Yes / No / Unknown	
Stratification	Are the strata well defined, known in advance and stable?	Yes / No / Unknown	
	Is there an overstratification leading to excessive imputation?	Yes / No / Unknown	
Selection	Is sampling probability based (e.g. stratified random with spatial strata, PPS)?	Yes / No / Unknown	
IMPLEMENTATION			
QUESTION		ANSWER	COMMENTS (INCLUDING MAGNITUDE AND DIRECTION OF BIAS)
Selection	Has the survey been designed to maximize precision?	Yes / No / Unknown	
	Are there protocols in place and have they been followed for subsamples (selection of individuals, times, boats, biological samples)?	Yes / No / Unknown	
	Are the right sites, times, respondents, biological data sampled?	Yes / No / Unknown	
	Is there a language barrier (tourist fishery)?	Yes / No / Unknown	
	Is there a preference not to engage with illegal fishers (e.g. threatening behavior)?	Yes / No / Unknown	
	Has the assignment been completed?	Yes / No / Unknown	
Nonresponse	Are response rates recorded and evaluated?	Yes / No / Unknown	

	Are refusal rates (e.g. according to spatial issues, fishing in MPAs or fishing for high value species) recorded and evaluated?	Yes / No / Unknown	
	Have you re-evaluated refusals?	Yes / No / Unknown	
	Have you accounted for not completed assignments (unobserved sample bias)?	Yes / No / Unknown	
Recall	Is the recall period appropriate?	Yes / No / Unknown	
	Does recall period match fishing season?	Yes / No / Unknown	
Effort	Is effort well defined (unit, fishing mode, target species, location) and related to CPUE measures?	Yes / No / Unknown	
	Is the concept of effort understood by respondents?	Yes / No / Unknown	
	Is it possible to record incorrect fishing areas?	Yes / No / Unknown	
Catch	Is catch verified by surveyors (e.g. all filleted, don't show)?	Yes / No / Unknown	
	Is species identification and naming reliable?	Yes / No / Unknown	
	Is there a clear division between fish kept and fish released?	Yes / No / Unknown	
	Are there any high-valued/threatened species taken in the fishery that might be unreported?	Yes / No / Unknown	
	Is there a digit preference in the reports?	Yes / No / Unknown	
ANALYSIS			
QUESTION		ANSWER	COMMENTS (INCLUDING MAGNITUDE AND DIRECTION OF BIAS)
General	Does the estimation procedure follow the survey design?	Yes / No / Unknown	
	Has imputation been used to account for missing observations and, if so, is the procedure documented?	Yes / No / Unknown	
	Has the precision of estimates been calculated and, if yes, where are the documented?	Yes / No / Unknown	
	Has there been weighting to correct for nonresponses/avidity bias	Yes / No / Unknown	
	In panel surveys, have those selected changed their fishing pattern or activity?	Yes / No / Unknown	
	Is the bias caused by drop-outs and drop-ins in a panel corrected for?	Yes / No / Unknown	
WGRFS ASSESSMENT OF SURVEY			
WGRFS summary assessment of key bias and how the survey design could be improved to account for these biases in future. This will form the basis of any advice that is provided to end users on the quality of the estimates produced.			

