DQWG Kick-off Meeting
23 September 2008
Bath, UK

Record of Discussion

Attendees:	Organization	e-mail
Shepard Smith (Chair)	USA, NOAA	shep.smith@noaa.gov
Chris Howlett (Vice Chair)	UKHO	chris.howlett@ukho.gov.uk
Louis Maltais	Canada, CHS	louis.maltais@dfo-mps.gc.ca
Lee Alexander	Univ. of NH	lee.alexander@unh.edu
Maarten Peters	CARIS, BV	mpeters@caris.nl
Bjorn van Liet	CARIS, BV	bvvliet@caris.nl
Hugh Astle	CARIS	Hugh.Astle@caris.com
Matthew Carle	CARIS	matthew.carle@caris.com

1. **Introduction**
Chair opened meeting and provided a brief overview. Six attendees then introduced themselves.

Agenda
1. Introduction
2. Review Terms of Reference
3. Review anecdotal motivation for publication of quality indicators in navigation products
4. Review status of various HOs in implementation of CATZOC and other quality indicators
5. Discuss other uses for data quality information
6. Brainstorm a long-term vision for data quality in navigation products
7. Evaluate proposal referred from TSMAD for modifications to S-57
   - -Refinement of definition of CATZOC "A"
   - -Harmonize ZOC definitions with new S-44 ed 5 Survey orders
   - -Display issues
8. Develop work plan
   - -Recruitment of new members
   - -Future meetings
   - -Other work ahead
   - -Report to CHRIS

2. **Terms of Reference**
Reviewed TOR that was prepared at CHRIS19, 5-9 Nov 2007.

3. Case Studies
- Maritime Pilots on Columbia River (USA) and Frazier River (Canada) use ship safety contours/depth area overlays (vector data on raster or vector chart) derived from very recent (24 - 48 hr) surveys performed by Public Works or US Army Corps post-dredging surveys. Functional utility of information relates to being the most recent information. The only data quality information is the date of the survey, and for rapidly changing areas, this is by far the most important quality indicator.

- M/V Octopus Incident – Original lead-line survey (1850) used to compile paper chart had sparse sounding density. Vessel grounded on rocky ridge that was uncharted. Paper chart had a source diagram, vector chart in use on ECS did not contain any data quality information. Vessel changed draft by lowering spud legs to stabilize itself, effectively making it a deep draft vessel operating in an area typically used only by smaller craft. MCA survey in same year stopped just hundreds of meters short of this shoal. Recommendations from investigation include provision of data quality information in the ENC, and a method to trigger an alarm if a user is intending use beyond the fitness of the chart.

- QE2 grounding in Martha's Vineyard Sound. Rock ridge was known and marked, but there had never been a survey with object detection in the area and least depths on all rocks was not known. QE2 was operating at high speeds in shoal water, which increased dynamic draft considerably. There were no source diagrams on US charts at the time.

-MCA Ship Anglian Sovereign and NOAA Ship Miller Freeman. Each ship grounded on uncharted shoals in the course of conducting research or survey operations in unfrequented areas.

-RFA tanker-in the course of a military exercise, a British tanker hid behind an island in an area not frequented by deep draft vessels. They grounded on an uncharted shoal which turned out to have a least depth of 3m in an area of 20m. The sparse soundings from the last survey revealed no indication of shoaling in the area.

-Cruise ships in Scotland, Alaska, and Antarctica routinely venture into poorly-surveyed or unsurveyed areas. UK and US survey efforts are not keeping up with the trend toward getting off the beaten track. The cruise ship operators seem to know the quality of the data is poor, especially in Alaska and Antarctica.

4. HO Status

UKHO-Source diagrams on paper/rasters, CATZOC implementation ongoing. On UKHO produced ENC (mainly UK home waters) CATZOC on a survey level. For other ENCs CATZOC is at the product level (so each ENC has a single ZOC), not at the level of individual surveys. There is general concern about the onerous definition of ZOC "A." UKHO is highly motivated to improve publication of quality information by Octopus and tanker groundings.

NOAA-Source diagrams on paper/rasters. M_QUAL objects not in use over concern with the ZOC "A" definition. There is a mixture of requirement to indicate a distinction between really inadequate surveys and good surveys and to show timeliness among good surveys.

CHS-Canadians have source diagrams on paper/raster but they don't publish data quality in the ENCs. Louis Maltais's Quebec Region has responsibility for the St Lawrence River, which has 300 km of low-underkeel clearance river in heavy use. The quality distinctions that need to be made are between good but outdated surveys and newer surveys.

There were no other testimonials from other HOs at this meeting. There were some emails circulated by TSMAD about a year ago to a number of (mostly European) HOs that indicate that the US, Canada, and UK experiences are not atypical.

5. **Potential Uses of Data Quality Info**

We brainstormed some other uses of data quality information beyond real-time or route planning decision support for mariners.

-Survey planning and priority-make efficient use of scarce survey resources to minimize risk to surface shipping.

-Communications with mariners on survey requirements.

-Educating mariners about the breadth of survey quality

-Internal tracking of survey accomplishment. All modern surveys do not meet a uniform standard, and some surveys that were intended to meet a certain standard do not achieve this, due to equipment problems, poor conditions, poor survey management, or time constraints.

6. Brainstorming of long-term vision for data quality

Needed properties in a quality tracking and publication system

-Actionable information to the mariner (is what I am doing or planning to do advisable?)

-Flexibility to be used for other purposes

-Make meaningful distinctions among a wide variety of survey types.

Principles

-HOs should database a variety of quality parameters such as depth accuracy, horizontal resolution, object detection, and date of survey, in order to facilitate changing quality indicators, and quality indicators that change over time in areas that are expected to have changed since the time of the survey.

-A quality indicator is interpreted in the context of a particular use. While there are a wide variety of uses, we can approximate quality requirements for surface vessels by confidence in expected underkeel clearance. Any warning must take into account the local charted water depth and draft of the vessel.

Working Idea

-The highest level quality indicator from an HO should be a Fitness for Use, the main attribute of which is Depth Confidence, measured in meters, which is based on

- survey accuracy
- object detection limits of the survey
- shoal-side residuals due to nautical cartography
- time elapsed since the survey
- known or estimated seafloor erosion, deposition, or mobility
- expected but unsurveyed marine debris (such as after flooding)
- expected but unsurveyed depth changes due to a large event (such as earthquake or storm)

-This high level Depth Confidence may be supplemented with component quality indicators.

-One might envision some sort of Root-Sum-Square combination of inputs from the above components that would yield a depth confidence valid for today.

-One might also envision an analysis of current use using AIS tracks which yields areas of frequent and infrequent navigation, and the underkeel clearance tolerances used by traffic during the observation period.

-One could also envision specifying survey requirements geared specifically to the underkeel clearance requirements of current use.

-By publishing a depth confidence quality indicator, an HO might guide shipping to use areas and routes which are known well enough to support their use. If the depth confidence published is insufficient for their current or planned use, this becomes the starting point in discussions on new survey requirements.

-One could also envision mapping new surveys to a depth confidence requirement. For example, a special order survey with sub-meter accuracy and 1m object detection might be mapped to a depth confidence of 1m right after the survey was done.

7. **Evaluation of French TSMAD proposal**

Recommendation 1:

Modify and clarify the ZOC A1 and A2 "seafloor coverage" definitions in S-57, by changing the wording from "All significant seafloor features detected and depths measured." to "Most significant seafloor features detected and depths measured."

The assembled group thought that "most" considerably undersold the level of care associated with a survey conducted with object detection, and that it would be commonly understood to mean a majority of features. If true, this would be only marginally more useful to a transiting vessel than finding none of them.

We proposed language which echoes the S-44 language describing object detection surveys.
"Survey conducted using detection systems, procedures, and trained personnel designed to detect and measure depths on significant seafloor features. Significant features are included on the chart as scale allows."

Recommendation 2: Harmonization of S-44 with CATZOC

Improve alignment between S44 and S57 ZOC criteria for "significant features" detection.
a/ for ZOC A1 :
- for depths from 0 to 30 meters : use special order "feature detection" criteria : Cubic features > 1 m
- for depths beyond 30 metres : slightly modify the CATZOC criterion to read : Cubic features > 10% of depth – 2 meters

b/ for ZOC A2 : use order 1a "feature detection" criteria : cubic features > 2 metres, in depths up to 40 metres; 10% of depth beyond 40 metres

The proposal essentially aims to align special order with ZOC A1, Order 1a with ZOC A2, and Order 2 with ZOC B.

The assembled group discussed this proposal. As it stands now, the definition of significant seafloor feature under ZOC A1 is more stringent even than S-44 special order. ZOC A1 requires 10% depth below 10m, 1m between 10m and 30m, where Special Order requires 1m at all depths.

The assembled DQWG agrees with TSMAD that ZOC A1 object detection size needs to be relaxed.

The ZOC A2 definition includes 20m position accuracy as well as 1m +2% depth accuracy. This is really an outdated standard, since nearly all systematic surveys today far exceed these accuracies. It would be a fairly gross understatement to align a modern Order 1a survey, which comprise the bulk of modern surveys, with position and depth accuracies more applicable to singlebeam and SSS surveys using 1980s technology.

The assembled DQWG thought that it would be better to relax ZOC A1 to align completely with the S-44 ed. 5 Order 1a surveys. This requires relaxation of the feature detection size and position error. The proposed changes are shown in the table following this discussion. ZOC A1 would then also include Special Order surveys. There was some concern that some HOs were already mapping Order 1(a) surveys to CATZOC A1, and a clarification that would make this untenable would create rework for those early adopters that have been using CATZOC to date.

We thought it would be better to create a new A0 ZOC that would align with modern Special Order, however, we thought that this would be beyond the scope of the "minor tweaks" that we are allowing ourselves to S-57 and the ENC product spec, and would be better left to S-100/101.
Under our proposal, ZOC A2 would not map to any modern Order survey. Order 1b and 2 surveys would both map to ZOC B.

DQWG Proposed Re-Alignment of CATZOC, changes are highlighted, old values in red

1	2	3		4	5
ZOC [1]	Position Accuracy [2]	Depth Accuracy [3]		Seafloor Coverage	Typical Survey Characteristics [5]
A1	± 5 m + 5% depth	0.50 + 1%d		Full area search undertaken. (All) Significant seafloor features detected [4] and depths measured.	Controlled, systematic survey [6] high position and depth accuracy achieved using DGPS or a minimum three high quality lines of position (LOP) and a multibeam, channel or mechanical sweep system.
		Depth (m)	Accuracy (m)		
		10 30 100 1000	± 0.6 ± 0.8 ± 1.5 ± 10.5		
A2	± 20 m	= 1.00 + 2%d		Full area search undertaken. (All) Significant seafloor features detected [4] and depths measured.	Controlled, systematic survey [6] achieving position and depth accuracy less than ZOC A1 and using a modern survey echosounder[7] and a sonar or mechanical sweep system.
		Depth (m)	Accuracy (m)		
		10 30 100 1000	± 1.2 ± 1.6 ± 3.0 ± 21.0		
B	± 50 m	= 1.00 + 2%d		Full area search not achieved; uncharted features, hazardous to surface navigation are not expected but may exist.	Controlled, systematic survey achieving similar depth but lesser position accuracies than ZOCA2, using a modern survey echosounder[5], but no sonar or mechanical sweep system.
		Depth (m)	Accuracy (m)		
		10 30 100 1000	± 1.2 ± 1.6 ± 3.0 ± 21.0		
C	± 500 m	= 2.00 + 5%d		Full area search not achieved, depth anomalies may be expected.	Low accuracy survey or data collected on an opportunity basis such as soundings on passage.
		Depth (m)	Accuracy (m)		
		10 30 100 1000	± 2.5 ± 3.5 ± 7.0 ± 52.0		
D	worse than	Worse Than		Full area search not achieved, large depth	Poor quality data or data that cannot be quality

	ZOC C	ZOC C	anomalies may be expected.	assessed due to lack of information.
U	Unassessed - The quality of the bathymetric data has yet to be assessed			

Remarks:

To decide on a ZOC Category, all conditions outlined in columns 2 to 4 of the table must be met.

Footnote numbers quoted in the table have the following meanings:

1 The allocation of a ZOC indicates that particular data meets minimum criteria for position and depth accuracy and seafloor coverage defined in this Table. Data may be further qualified by Object Class AQuality of Data@ (M_QUAL) sub-attributes as follows:

a) Positional Accuracy (POSACC) and Sounding Accuracy (SOUACC) may be used to indicate that a higher position or depth accuracy has been achieved than defined in this Table (e.g. a survey where full seafloor coverage was not achieved could not be classified higher that ZOC B; however, if the position accuracy was, for instance, " 15 metres, the sub-attribute POSACC could be used to indicate this).

b) Swept areas where the clearance depth is accurately known but the actual seabed depth is not accurately known may be accorded a higher ZOC (i.e. A1 or A2) providing positional and depth accuracies of the swept depth meets the criteria in this Table. In this instance, Depth Range Value 1 (DRVAL1) may be used to specify the swept depth. The position accuracy criteria apply to the boundaries of swept areas.

c) SURSTA, SUREND and TECSOU may be used to indicate the start and end dates of the survey and the technique of sounding measurement.

2 Position Accuracy of depicted soundings at 95% CI (2.45 sigma) with respect to the given datum. It is the cumulative error and includes survey, transformation and digitizing errors etc. Position accuracy need not be rigorously computed for ZOCs B, C and D but may be estimated based on type of equipment, calibration regime, historical accuracy etc.

3 Depth accuracy of depicted soundings = a + (b%d)/100 at 95% CI (2.00 sigma), where d = depth in metres at the critical depth. Depth accuracy need not be rigorously computed for ZOCs B, C and D but may be estimated based on type of equipment, calibration regime, historical accuracy etc.

4 Significant seafloor features are defined as those rising above depicted depths by more than:

Depth	Significant Feature
a. <40 m	2 m
b. >40 m	10% depth

A full seafloor search indicates that a systematic survey was conducted using detection systems, depth measurement systems, procedures, and trained personnel designed to detect and measure depths on significant seafloor features. Significant features are included on the chart as scale allows. It is impossible to guarantee that no significant feature could remain undetected, and significant features may have become present in the area since the time of the survey.

Depth Significant Feature
a. <10 metres >0.1%depth,
b. 10 to 30 metres >1.0 metre,
c. >30 metres >(0.1%depth) minus 2.0 metres

5 Controlled, systematic (high accuracy) survey (ZOC A1, A2 and B) - a survey comprising planned survey lines, on a geodetic datum that can be transformed to WGS 84.

Position fixing (ZOC A1) must be strong with at least three high quality Lines of Position (LOP) or Differential GPS.
Modern survey echosounder - a high precision surveying depth measuring equipment, generally including all survey echosounders designed post 1970.

Mapping of S-44, CATZOC with Fitness for Use

Use (under consideration)	S-44 Survey	S-57 CATZOC	Object Detection
<1m UKC Critical under-keel clearance	Special Order	(A0) A1	1m
<2m UKC Depth-constrained	1a	A1	~~2m~~ <40m, 2m >40m, 10% depth
<5m UKC Coastal navigation		A2	--
<5m UKC Coastal navigation	1b	B	--
<5m UKC Coastal navigation	2	B	--
<20m	Other	C	--
>20m UKC Unconstrained by draft		D	
Not recommended	Unsurveyed	unsurveyed	--

* change all ZOC depth and horizontal accuracy to S-44

TSMAD Recommendation 3:

Investigate a change in the portrayal of M_QUAL and M_SREL to include the SUREND symbology. Afterwards, this may also need an encoding bulletin recommending member states to populate associated SUREND (and, optionally, SURSTA).

The DQWG assembled agree that survey age is a critical quality indicator, and agree that the de-emphasis of this in the composite quality indicator CATZOC is one of its major weaknesses. However, we don't believe that simply symbolizing SUREND will solve this problem. We prefer to explore a new composite quality indicator that would include a notion of applicability to today. Date alone doesn't tell the mariner about known changeable areas, reportedly changed areas, known accumulation of seafloor obstructions, or major events since the survey such as hurricanes or other major storms, etc. We also would prefer to make any display or alarms relevant to the vessel displaying it by only displaying quality information in areas where underkeel clearance may be an issue. This will require some retooling of the composite quality indicator that will be subject of the DQWG inquiry over the coming months. We have nothing to recommend for display at this time.

8. Work Ahead

It is of paramount importance to recruit a few additional active members of the DQWG in addition to our corresponding members. Louis Maltais from CHS was a very active member of this session and has shown interest in joining. We will circulate these minutes widely as well to signal the start of active, and hopefully interesting, work that may spark renewed interest among other HOs.

We also want to have some means to experiment with, demonstrate, and explain the ideas around a fitness for use composite quality indicator. To support this, we asked some of the Caris folks at the meeting to put together a new Object type with applicable attributes (in the style of an MIO) that we can use as a proving ground. It is our intention that the ultimate realization of this work will be inclusion in S-100/S-101. We also discussed the utility of a quality overlay that could be used with raster products as well as vector, but have no plans to promote a publishable product spec in the immediate future.

Data Quality MIO

FITUSE (Fitness of Use)

depcon (depth confidence)

10	1 metre
20	2 m
50	5 m
100	10 m
200	20 m
888	unreliable
999	unknown

INFORM
TXTDSC

The chair will be putting together a report to CHRIS based on the work of the DQWG to date and including a work plan and some of the recommendations contained in these minutes. It will circulate for (short-turnaround) comments during the week of Oct 6.

There will be another open meeting of the DQWG in conjunction with the Shallow Survey conference in New Hampshire October 20-24, time and place to be announced.

There will be a formal meeting of the DQWG in conjunction with the North American Hydrographic Conference in Norfolk, Virginia, on May 11, 2009.