



# IHO Data Quality Working Group

VTC, Feb. 8-9, 2022



Christos  
Kastrisios  
CCOM

**Depth Uncertainty  
Visualization**

Colin  
Ware  
CCOM

## User survey results on five alternative QoBD coding schemes

Christos Kastrisios

February 9, 2022



# IHO Data Quality Working Group

VTC, Feb. 8-9, 2022



Christos Kastrisios  
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## Depth Uncertainty Visualization

Colin Ware  
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Colin Ware  
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Christos Kastrisios  
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Brian Calder  
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## Depth Uncertainty Visualization & Integration

Rogier Broekman  
DQWG/NLHO

Lee Alexander  
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Tom Butkiewicz  
CCOM

**Data Quality Working Group**  
Feb. 4-7, 2020

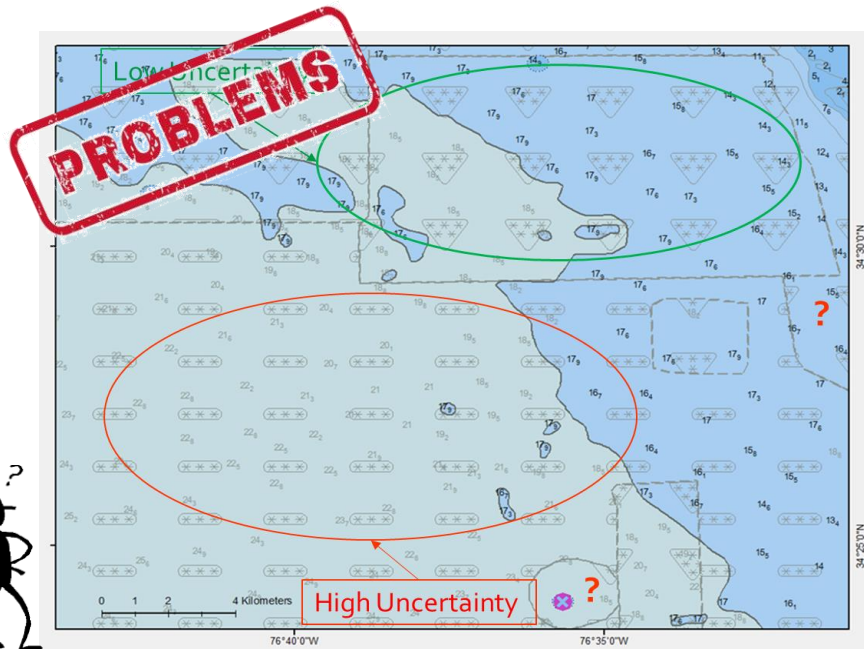
**IHO Data Quality Working Group**  
Monaco, Feb. 4-7, 2020

### An Alternative Methodology (to the star symbols)

Christos Kastrisios  
February 7, 2020

Christos Kastrisios  
February 9, 2022

# STAR SYMBOLOGY PROBLEMS

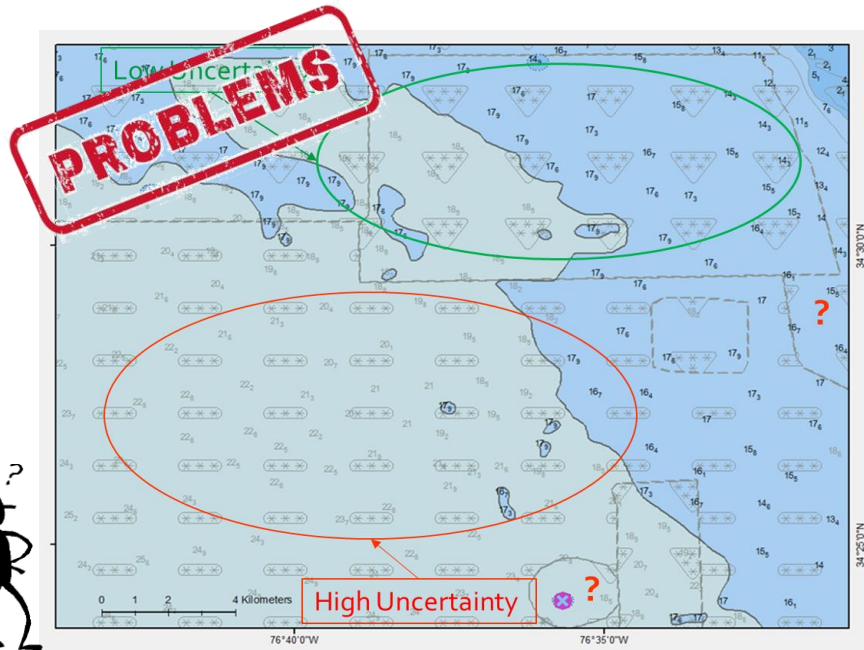


- CLUTTER
- Obscure depth information
- Visual weight is increased with the increase of the quality of data
- Not intuitive
- May not fit in small areas
- Dominate the screen

***“The current staggered pattern symbology of CATZOC should not be used in S-101”***

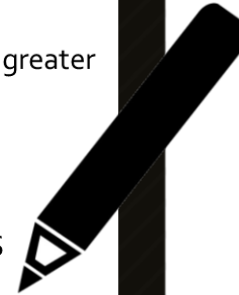
DQWG14-08A

# NEW SYMBOLOGY REQUIREMENTS

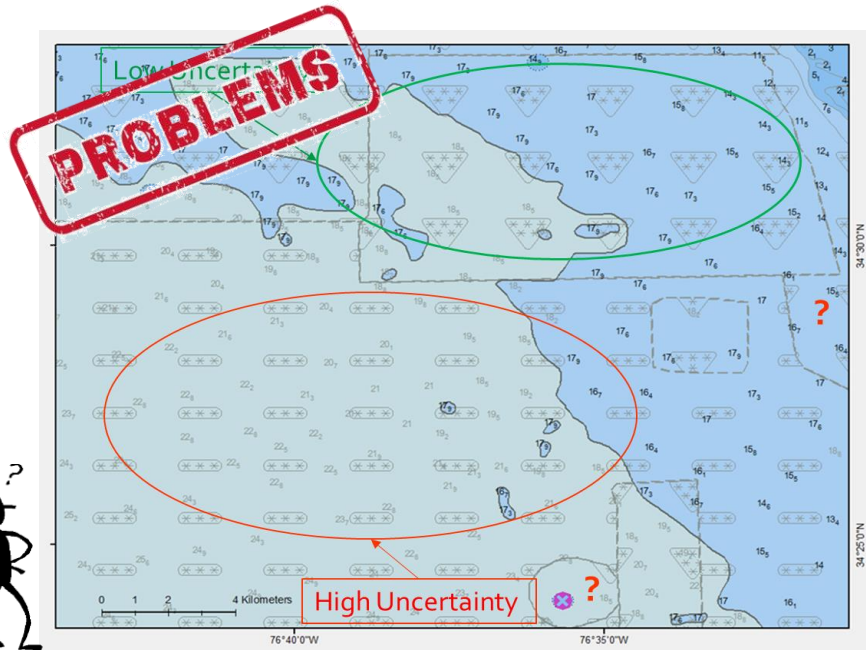


## Requirements

- Minimally interfere with the other charted information.
- Unambiguously relate to the QoBD categories.
- Emphasize the areas of greater uncertainty.
- Be easy to memorize.
- Be effective in all ECDIS modes.

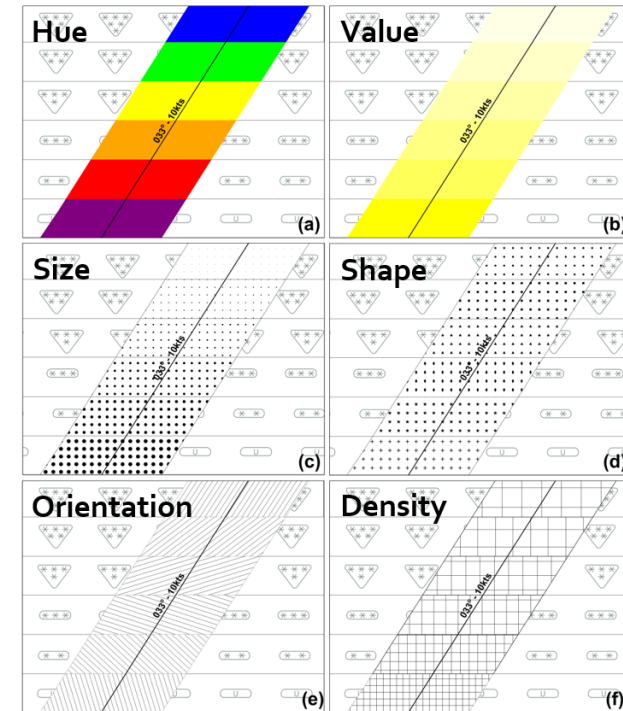


# VISUAL VARIABLES EVALUATION



## Requirements

- Minimally interfere with the other charted information.
- Unambiguously relate to the QoBD categories.
- Emphasize the areas of greater uncertainty.
- Be easy to memorize.
- Be effective in all ECDIS modes.



# PROPOSED SOLUTION




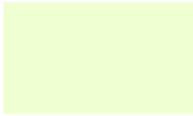





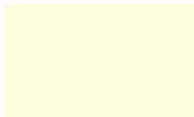








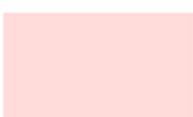


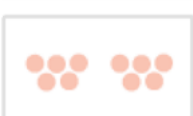



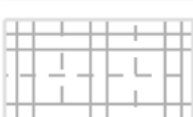




QoBD	Lines	Dot Clusters
1		
2		
3		
4		
5		
U		

Sequence of textures consisting of countable elements

Benefits:

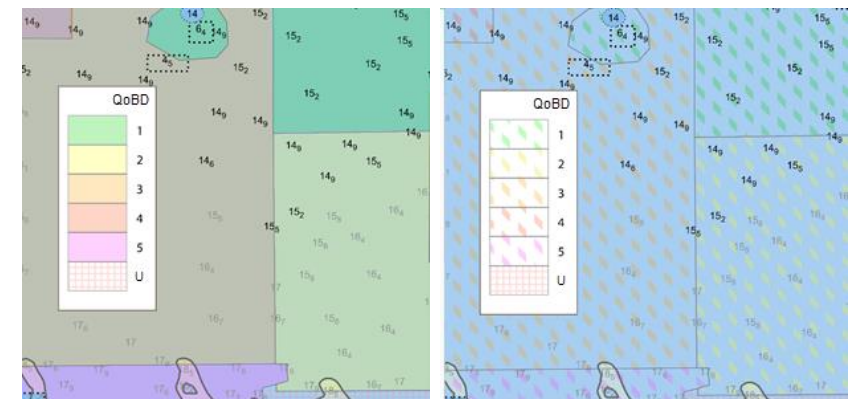
- ✓ Minimally used in ECDIS
- ✓ Minimally interfere with chart information
- ✓ The combination can be intuitive
- ✓ Good visual hierarchy

# ALTERNATIVE CODING SCHEMES

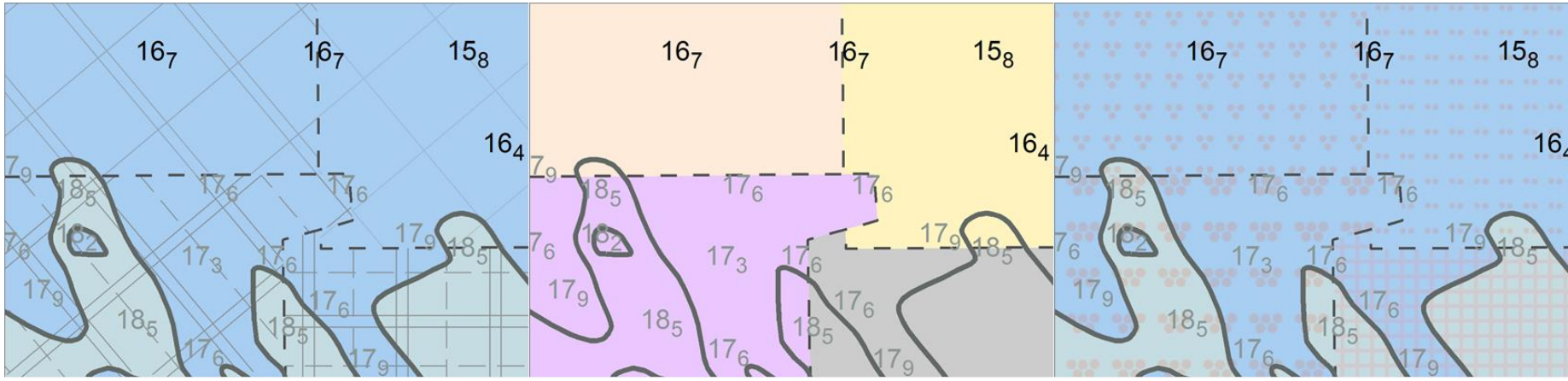
QoBD	Lines	Dot Clusters	Color Textures	Opaque Colors	Transparent Color
1					
2					
3					
4					
5					
U					

## 5 Coding Schemes :

- Lines
- Dot clusters
- Color textures
- Opaque colors
- Color lightness and transparency



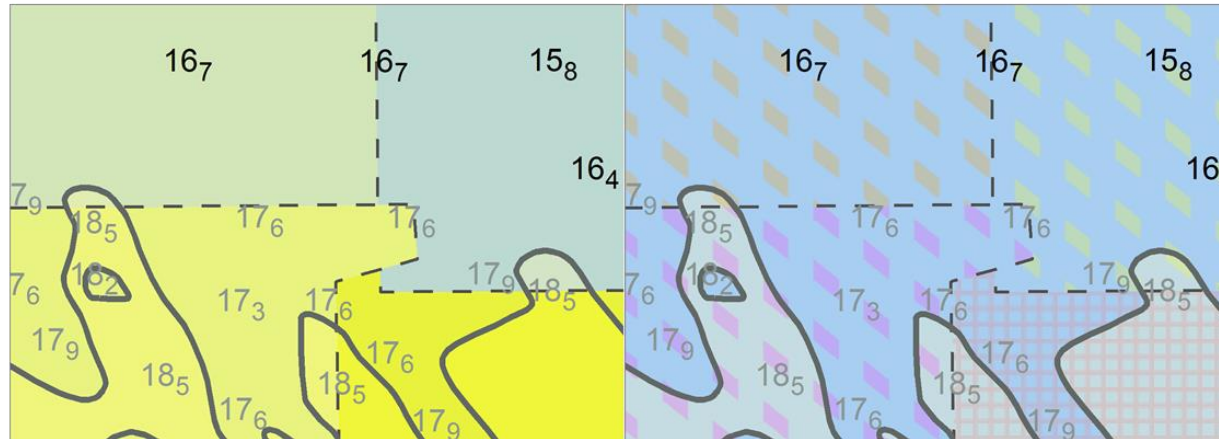
# ALTERNATIVE CODING SCHEMES



Lines

Opaque Colors

Dot Clusters



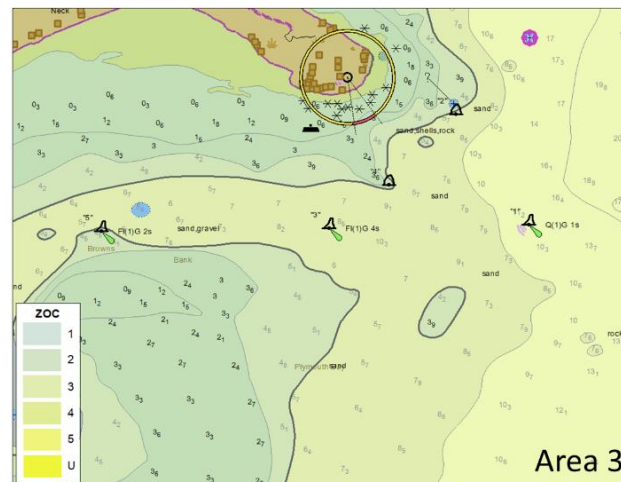
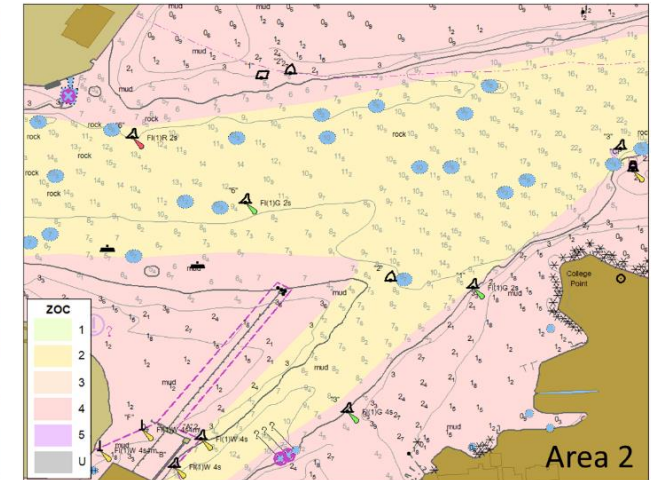
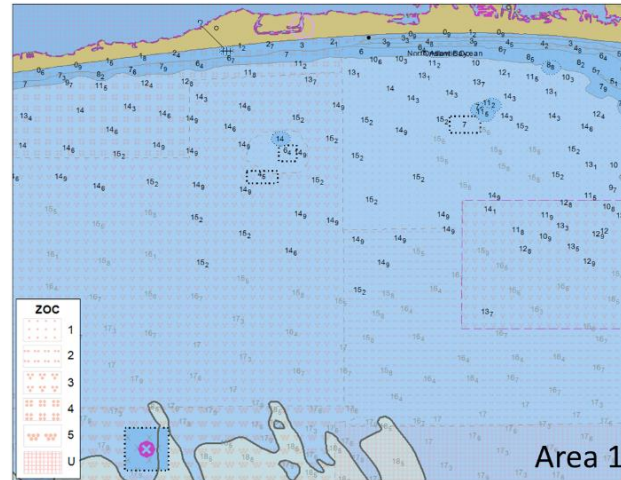
Transparent Color

Color Textures



# SURVEY STRUCTURE

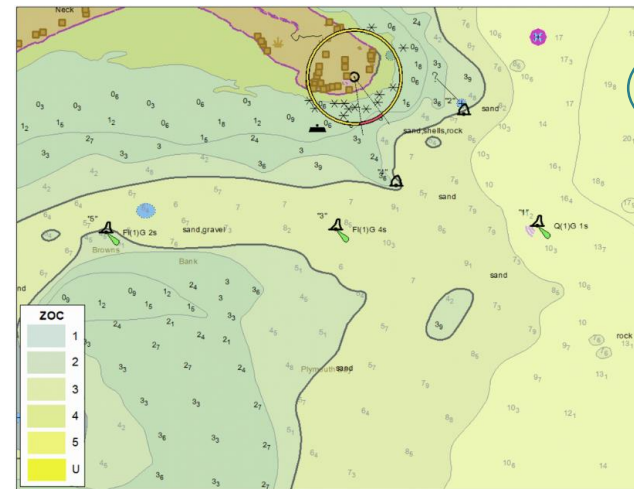
- Consent
- Introduction Section
- Evaluation Section
  - Ratings (Likert 0-6 scale for exceptionally bad-great performance)
  - Rankings (1-5 for worst-best)
- Demographics Section



Requirement	Sample Survey Question
1 - Minimally interfere with charted information	How clearly can you see the chart information (e.g., depths, shallow/deep depth areas)?
2 - Unambiguously relate to ZOC categories	Are the different ZOC categories distinct /unambiguous?
3 - Emphasize worse quality data	Are the areas of worse quality data more emphasized?
4 - Be easy to remember	Is the coding easy to remember?
5 - Be effective in all ECDIS modes	All Area 1 Dusk Questions

# SURVEY STRUCTURE

- Consent
- Introduction Section
- Evaluation Section
  - Ratings (Likert 0-6 scale for exceptionally bad-great performance)
  - Rankings (1-5 for worst-best)
- Demographics Section



**COLOR TRANSPARENCY**

There is only one ZOC category in the view/area. What is that?

1   2   **3**   4   5   U   AREA3Q1

---

How quickly did you identify this ZOC category? (0=Very Slowly, 6=Very Quickly)

0 1 2 3 4 5 6   AREA3Q2

How confident are you that you have identified the ZOC category correctly? (0=Not At All Confident, 6=Very Confident)

0 1 2 3 4 5 6   AREA3Q3

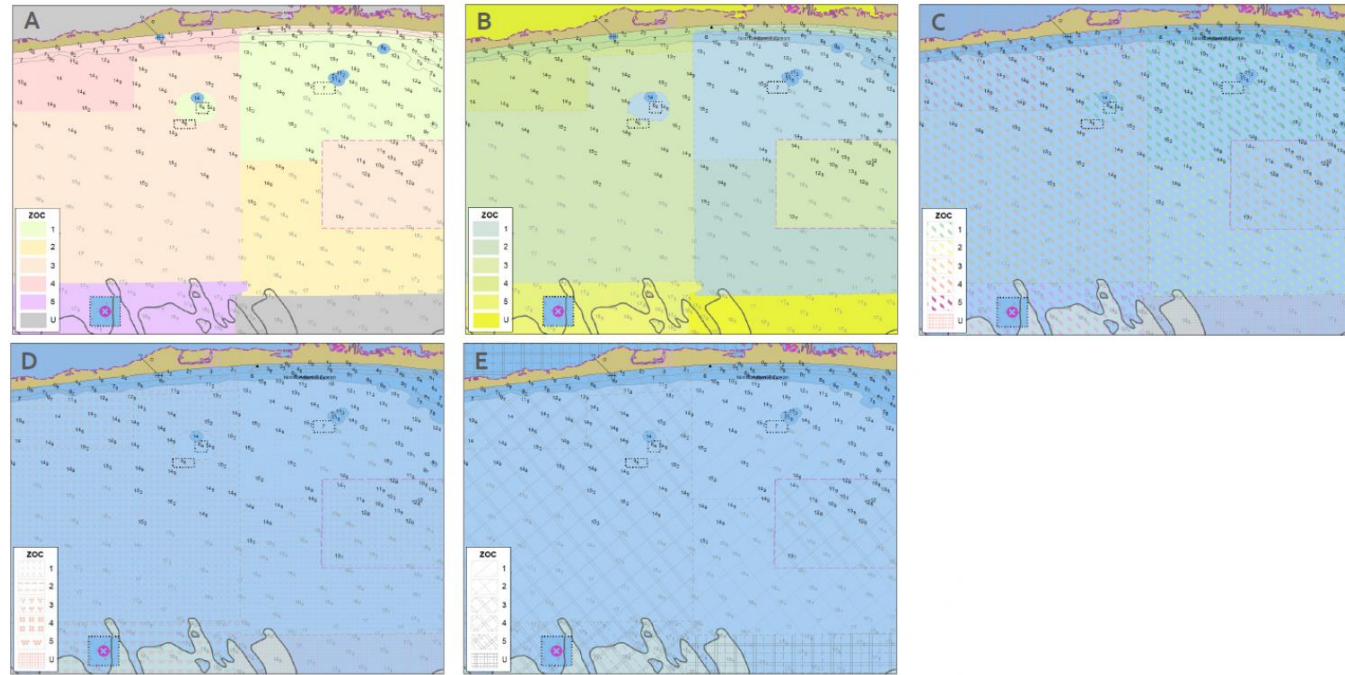
Would you be able to identify the ZOC category without the use of the legend/key? (0=Not At All, 6=Absolutely)

0 1 2 3 4 5 6   AREA3Q4

Area 3 Question 1	AREA3Q1	There is only one ZOC category in the view/area. What is that?
Area 3 Question 2	AREA3Q2	How quickly did you identify this ZOC category?
Area 3 Question 3	AREA3Q3	How confident are you that you have identified the ZOC category correctly?
Area 3 Question 4	AREA3Q4	Would you be able to identify the ZOC category without the use of the legend/key?

# SURVEY STRUCTURE

- Consent
- Introduction Section
- Evaluation Section
  - Ratings (Likert 0-6 scale for exceptionally bad-great performance)
  - Rankings (1-5 for worst-best)
- Demographics Section



Please rank the 5 alternatives from 1-worst to 5-best for the Day Bright Mode for their overall performance in meeting the requirements of the previous screen.

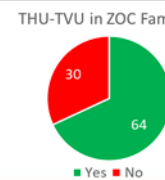
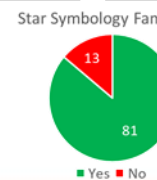
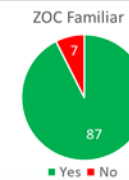
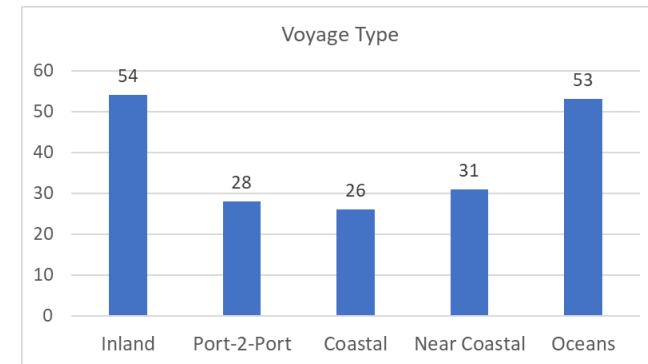
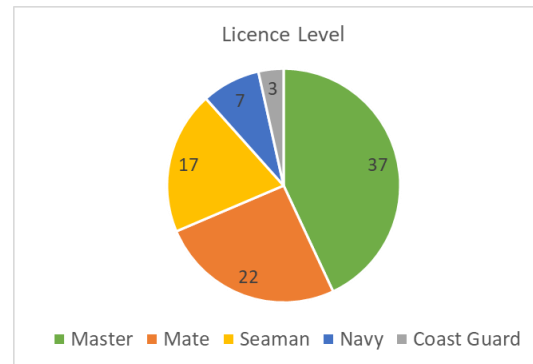
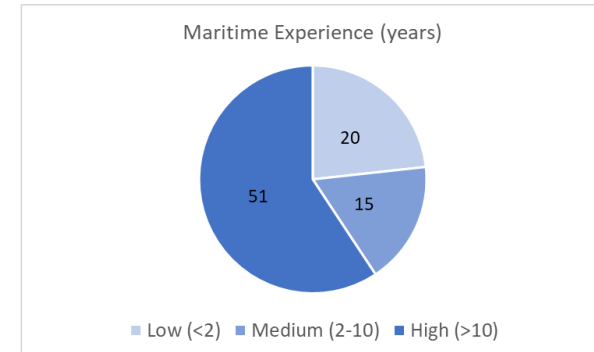
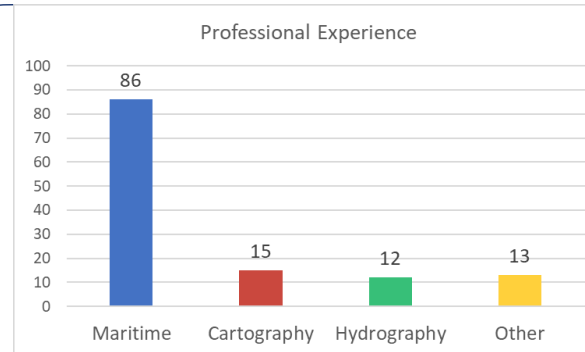
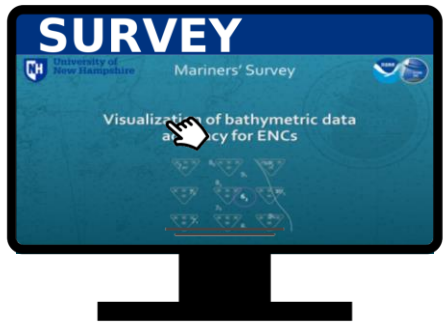
	1-Worst	2	3	4	5-Best
A - Opaque Colors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
B - Color Transparency	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
C - Color Stripes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
D - Dot Clusters	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
E - Lines	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



# PARTICIPANTS



94 Responses (Jan – Oct 2021)



# RESULTS

## CLUSTERING ANALYSIS

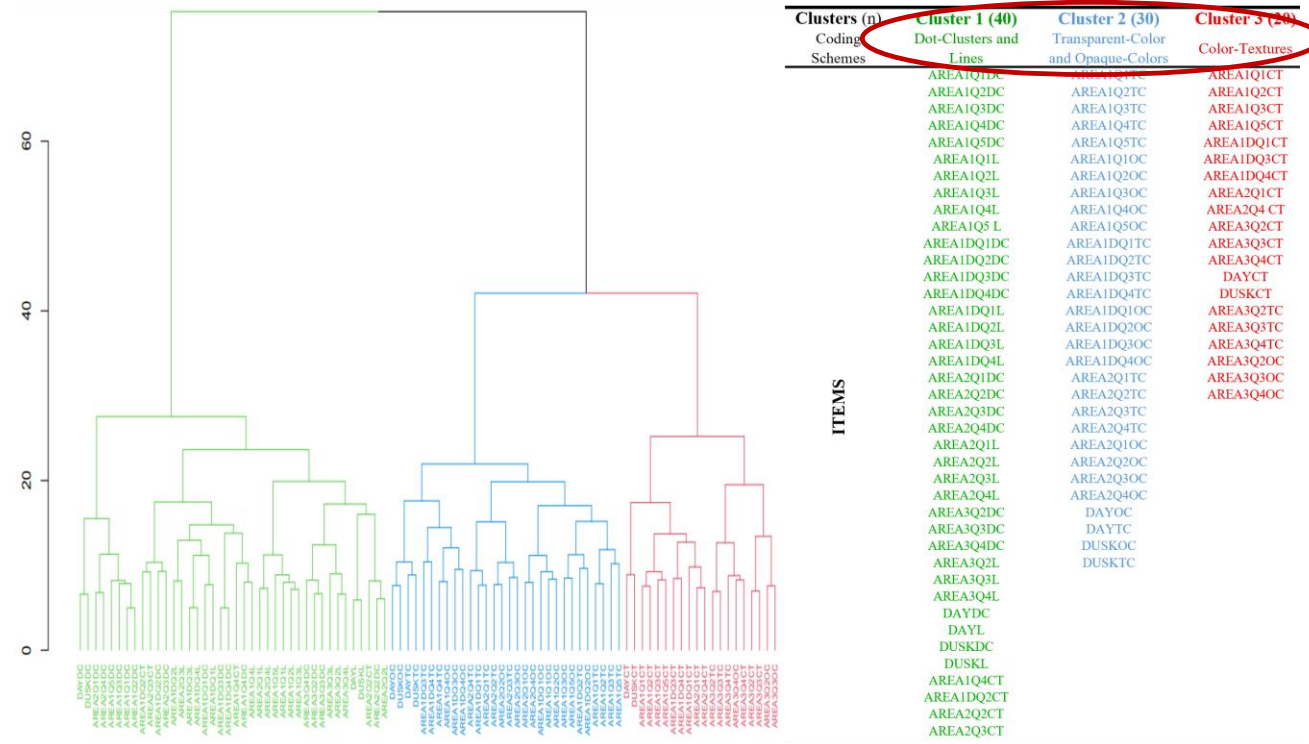


### ➤ Agglomerative Hierarchical Clustering analysis

- Cluster 1: Lines & Dot-Clusters
- Cluster 2: Opaque-Colors and Transparent-Color
- Cluster 3: Color-Textures

### ➤ Interpretation

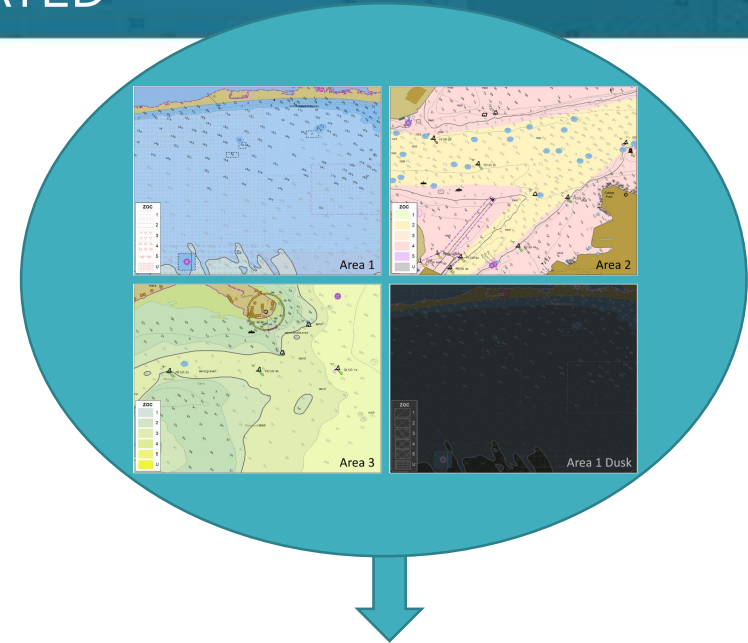
- If participant rated Lines high, same for Dot-clusters (and vice-versa)
- If participant rated Opaque-Colors high, same for Transparent-Color (and vice-versa)
- Color-Textures was treated separately but closer to Color-based schemes



Dendrogram (left) and items (right) of the clustering analysis

# RESULTS

## ALL 4 AREAS AGGREGATED



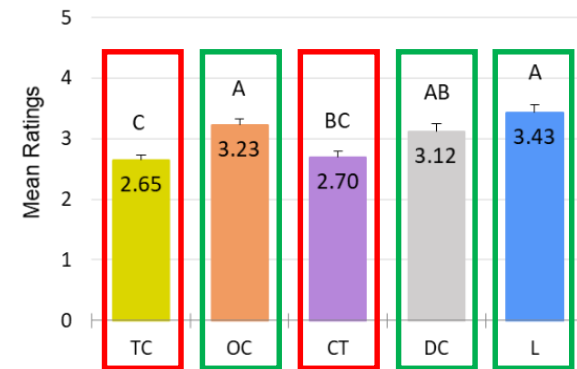
AREA		Coding Schemes					ANOVA	
		TC	OC	CT	DC	L	F	p
Area 1	mean rating (s.d.)	3.605	3.523	2.853	3.249	3.586	5.633	0.0002
		(1.149)	(1.197)	(1.151)	(1.418)	(1.291)		
Area 1 Dusk		2.381	3.270	2.384	2.616	3.183	9.931	<0.00001
		(1.101)	(1.240)	(1.282)	(1.344)	(1.366)		
Area 2		3.163	3.413	2.954	2.895	3.404	3.432	0.009
		(1.307)	(1.234)	(1.126)	(1.179)	(1.229)		
Area 3		1.434	2.698	2.601	3.717	3.558	103.097 <sup>1</sup>	<0.0001
		(1.175)	(1.184)	(1.148)	(1.763)	(1.674)		

<sup>1</sup>Kruskal -Wallis rank sum test – X<sup>2</sup>

Coding Schemes Comparisons	Mean ratings differences			
	Area 1	Area 1 Dusk	Area 2	Area 3 <sup>1</sup>
OC - TC	-0.081	<b>0.890***</b>	0.250	<b>8.939***</b>
CT - TC	<b>-0.751***</b>	0.003	-0.209	<b>8.582***</b>
DC - TC	-0.356	0.235	0.267	<b>11.061***</b>
L - TC	-0.019	<b>0.802***</b>	0.241	<b>10.995***</b>
CT - OC	<b>-0.670**</b>	<b>-0.887***</b>	-0.459	-0.380
DC - OC	-0.274	<b>-0.654**</b>	<b>-0.517*</b>	<b>5.684***</b>
L - OC	0.063	-0.087	-0.009	<b>5.031***</b>
DC - CT	0.395	0.233	-0.058	<b>6.147***</b>
L - CT	<b>0.733**</b>	<b>0.799***</b>	0.451	<b>5.484***</b>
L - DC	0.337	<b>0.567*</b>	<b>0.509*</b>	-0.925

\*<0.05, \*\*<0.01 and \*\*\*<0.001

<sup>1</sup>Multiple comparison test after Kruskal-Wallis

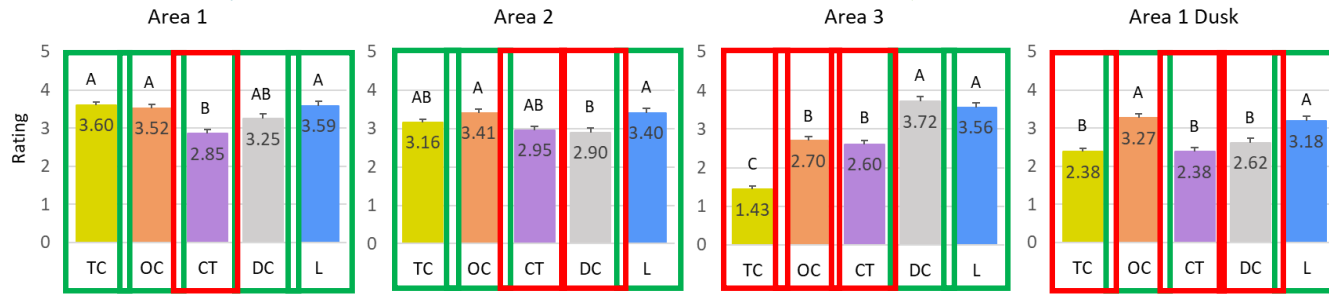
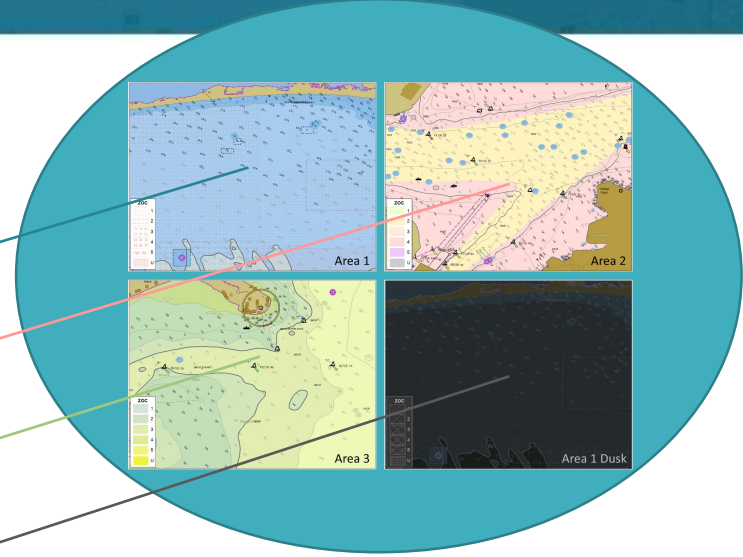


Aggregated mean ratings in all four evaluation areas

■ Transparent-Color ■ Opaque-Colors ■ Color-Textures ■ Dot-Clusters ■ Lines

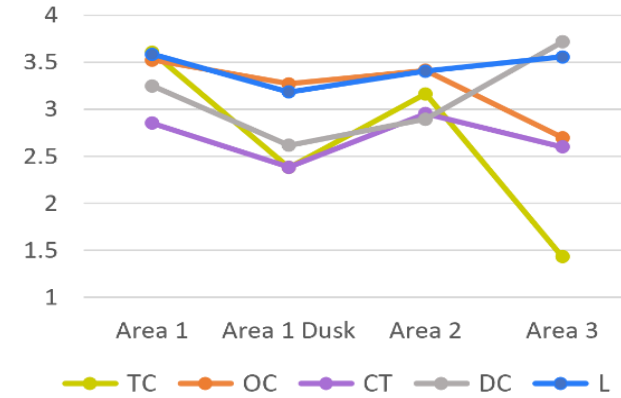
# RESULTS

## AREAS SEPARATELY



Aggregated mean ratings in each evaluation area

Coding Schemes - Areas Interactions

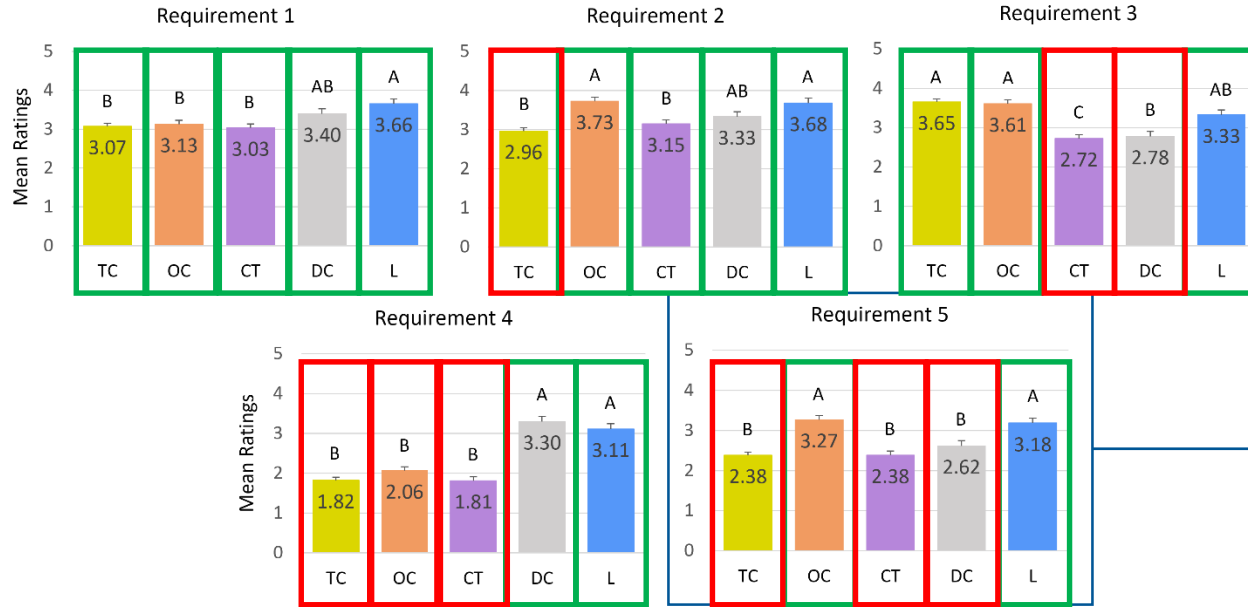


Aggregated mean ratings in all four evaluation areas

■ Transparent-Color 
 ■ Opaque-Colors 
 ■ Color-Textures 
 ■ Dot-Clusters 
 ■ Lines

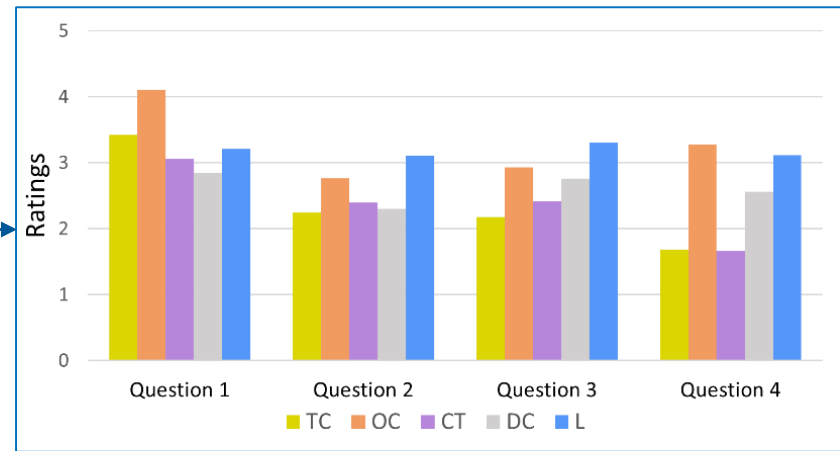
# RESULTS

## REQUIREMENTS



Aggregated mean ratings for the five application requirements

Requirement	Survey Question #
1 - Minimally interfere with charted information	AREA1Q4, AREA2Q2, AREA2Q3
2 - Unambiguously relate to ZOC categories	AREA1Q1, AREA1Q2, AREA2Q1, AREA3Q2, AREA3Q3,
3 - Emphasize worse quality data	AREA1Q5, AREA2Q4
4 - Be easy to remember	AREA1Q3, AREA3Q4
5 - Be effective in all ECDIS modes	AREA1DQ1, AREA1DQ2, AREA1DQ3, AREA1DQ4



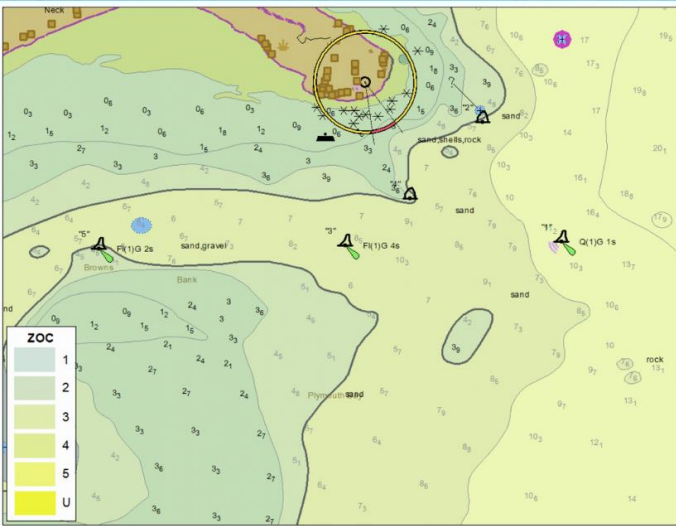
■ Transparent-Color ■ Opaque-Colors ■ Color-Textures ■ Dot-Clusters ■ Lines





# RESULTS

## AREA 3



**COLOR TRANSPARENCY**

There is only one ZOC category in the view/area. What is that?

1 2 3 4 5 U

AREA3Q1

How quickly did you identify this ZOC category? (0=Very Slowly, 6=Very Quickly)

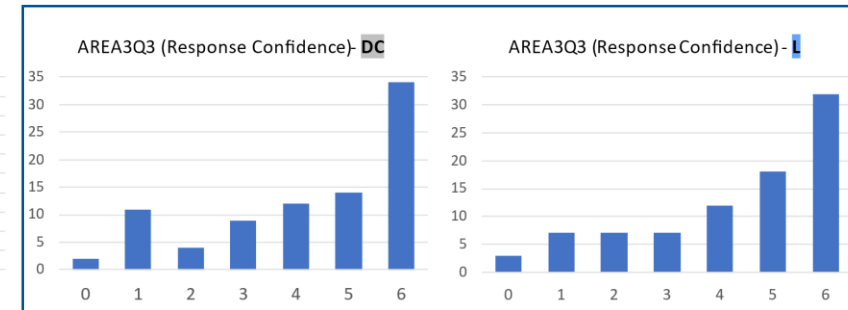
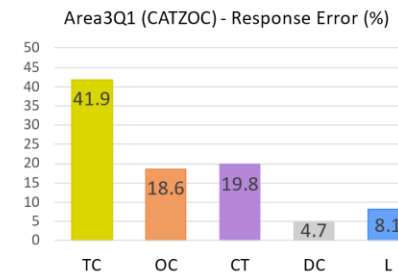
How confident are you that you have identified the ZOC category correctly? (0=Not At All Confident, 6=Very Confident)

Would you be able to identify the ZOC category without the use of the legend/key? (0=Not At All, 6=Absolutely)

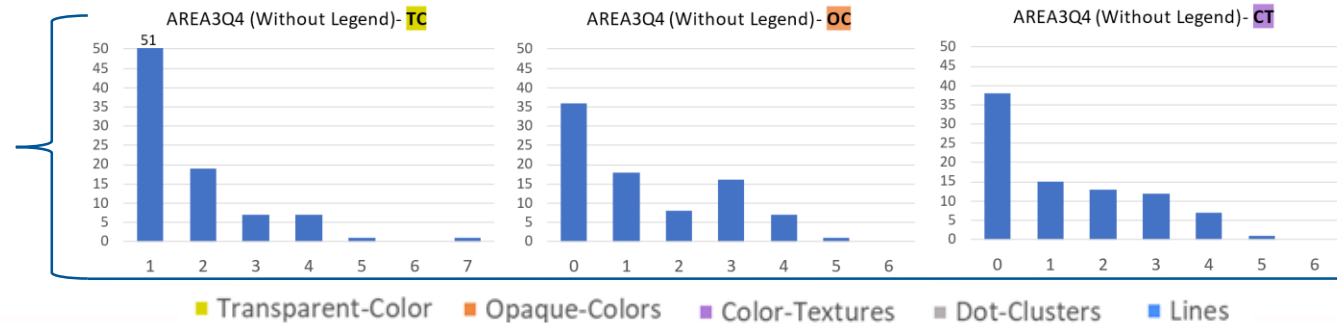
Area 3 Question 1	AREA3Q1	There is only one ZOC category in the view/area. What is that?
Area 3 Question 2	AREA3Q2	How quickly did you identify this ZOC category?
Area 3 Question 3	AREA3Q3	How confident are you that you have identified the ZOC category correctly?
Area 3 Question 4	AREA3Q4	Would you be able to identify the ZOC category without the use of the legend/key?

DC and L: Participants are very confident they identified the category correctly

Evaluation Area 3 and the Color Transparency and Lightness coding scheme with the respective questions.



TC, OC, CT: Identifying the category correctly without a legend would be difficult



# RESULTS

## RANKINGS



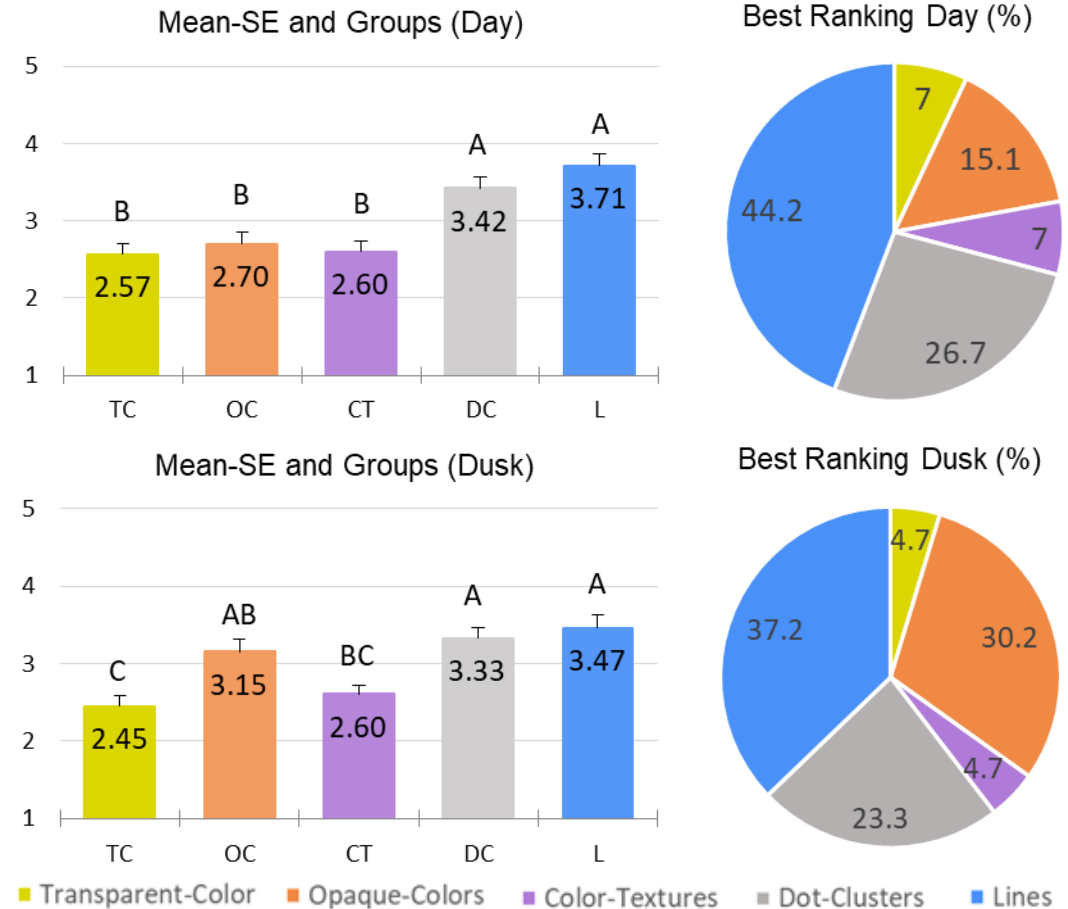
### ➤ Day-bright Mode

- Lines and Dot-Clusters were ranked significantly higher than Opaque-Colors, Transparent-Color, and Color-Textures
- Lines received the highest ranking and DC the second best
- Lines received 44.2% of the best ranking ("5") followed by DC and OC

### ➤ Dusk Mode

- Lines and Dot-Clusters were ranked significantly higher than Transparent-Color and Color-Textures
- Opaque-Colors significantly higher than Transparent-Color
- Lines received the highest ranking and DC the second best
- Lines received 37.2% of the best ranking ("5") followed by OC and DC

Means and groups (left), and best ranking percentages (right) of the final rankings in Day-Bright (top) and Dusk (bottom) modes



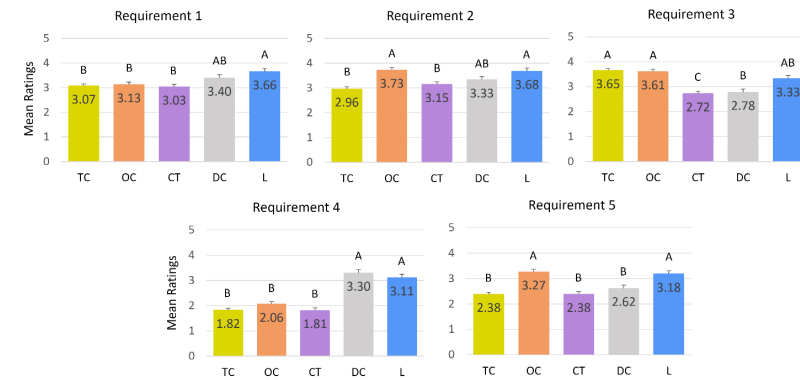
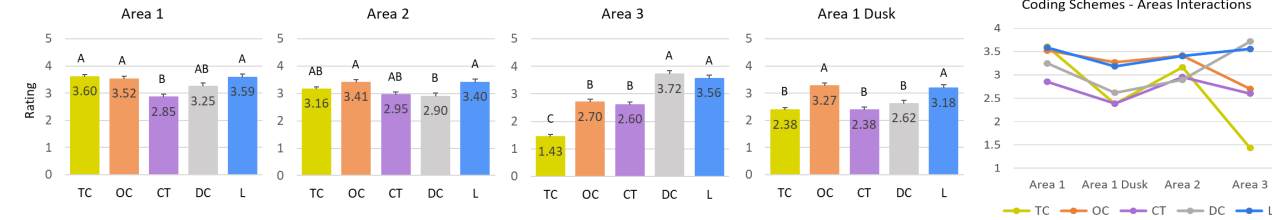
# RESULTS SUMMARY

## ➤ Lines

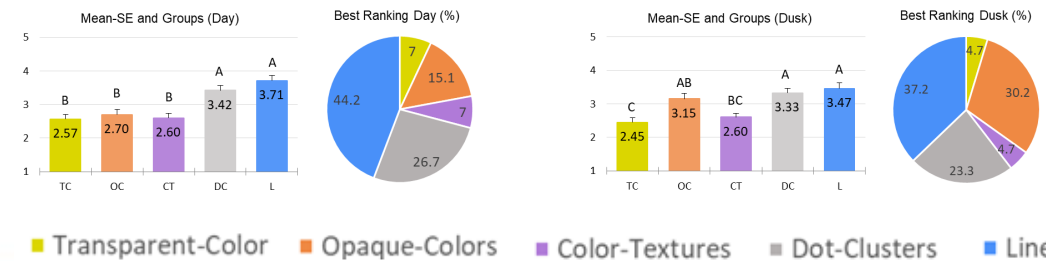
- Received the most positive and consistent ratings
- The only scheme with mean ratings over three in all four areas
- The only with mean > 3 in the 5 requirements
- First in mean rankings in Day and Dusk modes
- Received 44.2% and 37.2% of the best rankings ("5") in Day and Dusk

## ➤ Dot-Clusters

- The second best in mean rankings in Day and Dusk modes
- Particularly good in "not interfering with chart information" and "ease to remember"
- Less effective in "emphasizing areas of greater uncertainty" and "all ECDIS modes" (Dusk).
- Impressive increase from Area 2 to Area 3 (due to "countable elements")



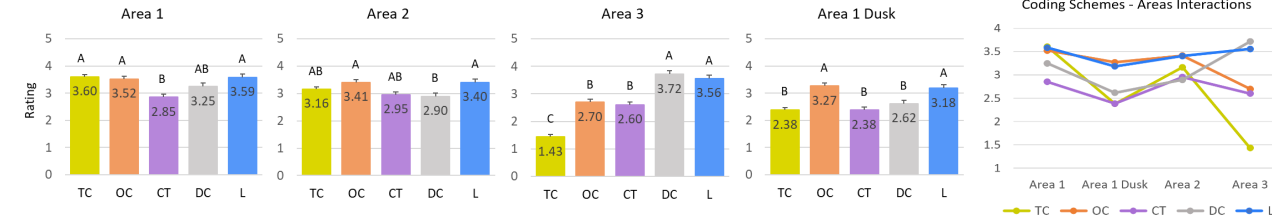
Requirement
1 - Minimally interfere with charted information
2 - Unambiguously relate to ZOC categories
3 - Emphasize worse quality data
4 - Be easy to remember
5 - Be effective in all ECDIS modes



# RESULTS SUMMARY

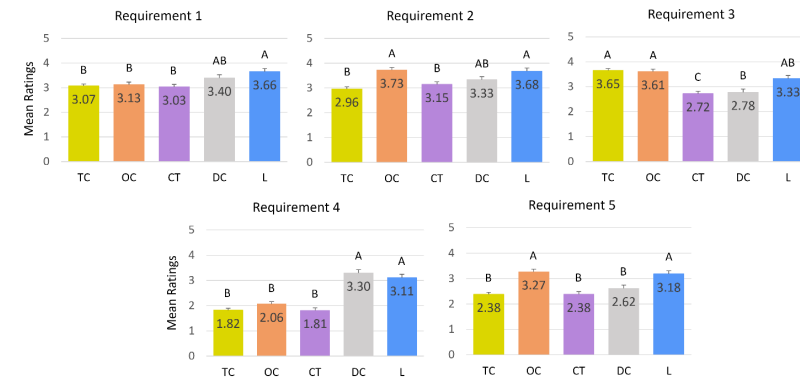
## ➤ Opaque-Colors

- Third in participants rankings
- Particularly effective in “relating to QoBD categories” and “emphasizing worse quality data”
- Least effective / problematic in “interfering with chart information” and “be easy to remember” requirements.
- Significant decrease in ratings from Area 1 and Area 2 to Area 3



## ➤ Transparent-Color

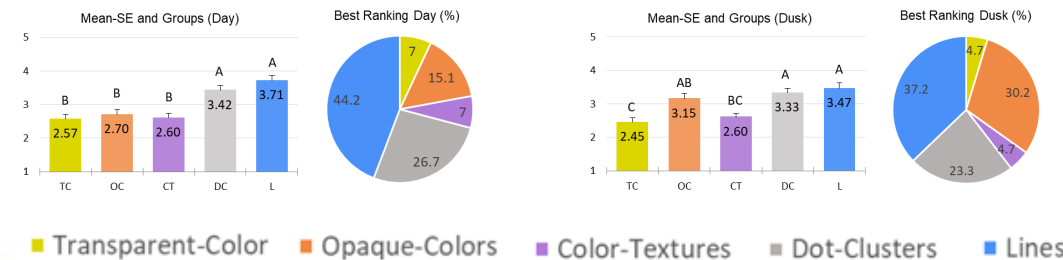
- Particularly effective in “emphasizing worse quality data”
- Relatively poor performance in everything else
- Impressive decrease in ratings from Area 1 and Area 2 to Area 3



Requirement
1 - Minimally interfere with charted information
2 - Unambiguously relate to ZOC categories
3 - Emphasize worse quality data
4 - Be easy to remember
5 - Be effective in all ECDIS modes

## ➤ Color-Textures

- (Unexpectedly) Poor performance in almost everything



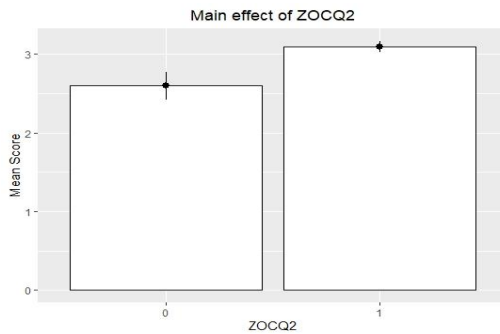
# RESULTS SUMMARY



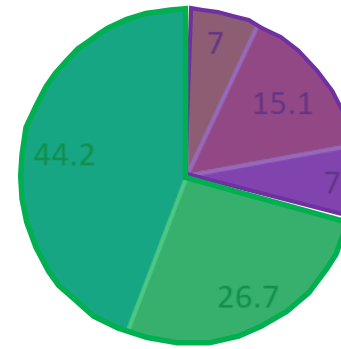
- Textures the most preferred, but
- Two big groups (**textures** & **colors**)
- One Texture & one Color to accommodate both groups?

## ➤ Aware of Star Symbology?

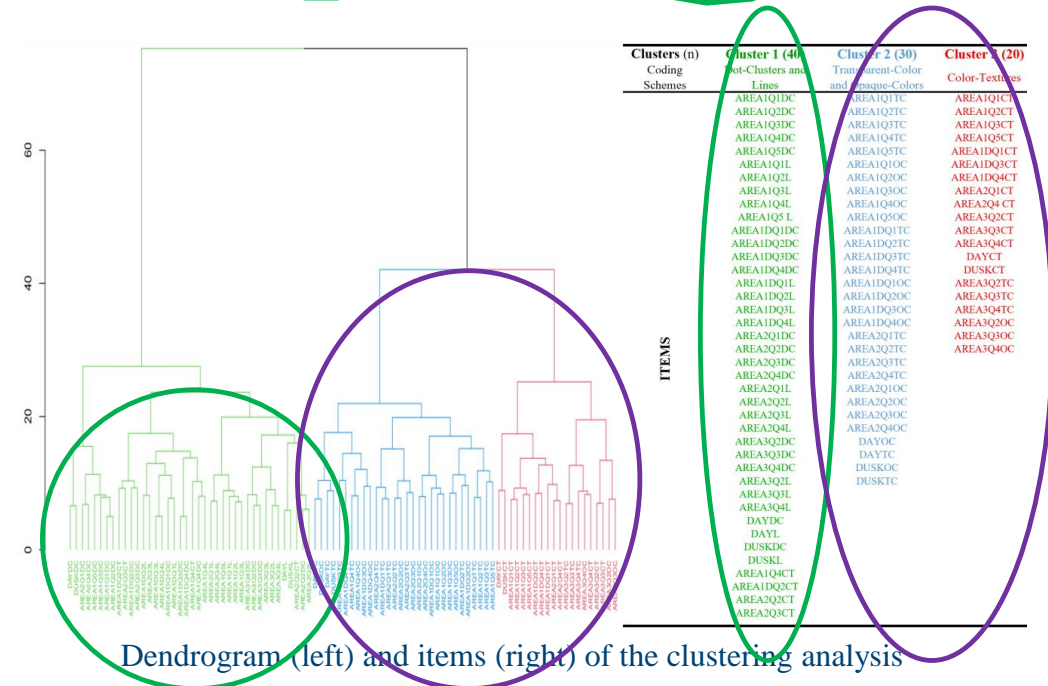
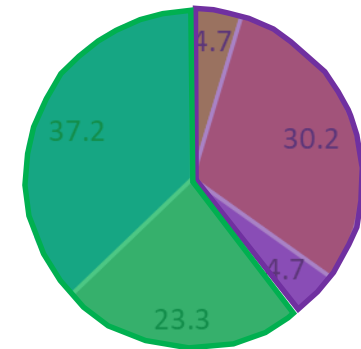
If Yes → happier with all schemes (than if not aware)



Best Ranking Day (%)



Best Ranking Dusk (%)



Dendrogram (left) and items (right) of the clustering analysis

# THANK YOU!

