Customer Needs and Use Assessment Survey

USE OF, SATISFACTION WITH, AND REQUIREMENTS FOR IN SITU SALINITY SENSORS

Conducted by the Alliance for Coastal Technologies

2007

I. OBJECTIVE

The fundamental goal was to assess user needs and applications and to provide the focus for an Alliance for Coastal Technologies (ACT, www.act-us.info) Technology Verification of conductivity and temperature sensors that provide in situ measurements of salinity. We are aware that values for salinity are often presented in a variety of ways (e.g., ppt, psu, pss, mg/l and µS/cm) with some more appropriate than others. However, the goal of this Customer Needs and Use Assessment is to better understand how salinity sensors are used, and not to promote a specific approach to recording/reporting salinity values. We hope this information can also assist manufacturers in refining salinity sensor technologies to better address user priorities.

II. SURVEY COMPOSITION

From July 10th to August 17th, ACT conducted a web-based survey to aid in a Customer Needs and Use Assessment of salinity sensors. ACT Headquarters and Partner personnel developed the questionnaire and the survey was created using SurveyMonkey.com, with the guidance of Riley Young Morse of the ACT Partner, Gulf of Maine Ocean Observing System. The survey contained a total of 18 questions (listed below along with their responses), which were divided into three sections: Application, Specifications, and Recommendations. Participants were asked to consider the primary in situ salinity sensor(s) they used when responding to each question.

III. DISTRIBUTION OF SURVEY

The majority of respondents received a request to participate in this online survey through email. However, several respondent also answered the survey at a booth hosted by the ACT Partner, Moss Landing Marine Laboratories, at the Coastal Zone 07 conference held in Portland, Oregon from July 22nd to the 26th.

IV. PARTICIPANT SELECTION PROCESS

To assure broad geographic coverage, regional outreach personnel at the eight ACT Partner Institutions nominated participants based on their professional interests, background, and expertise. Approximately 145 coastal resource managers, regulatory and environmental health agencies representatives, and scientific researchers were targeted to take part in the survey. Of those targeted, the following organizations had representatives participate:

- Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science
- Connecticut Department of Environmental Protection
- Environmental Protection of Hillsborough County

- Georgia Department of Natural Resources, Coastal Resources Division
- Great Lakes WATER Institute
- Green Eyes LLC
- Hood Canal Salmon Enhancement Group
- Horn Point Laboratory, University of Maryland Center for Environmental Science
- Humbolt State University
- International SeaKeepers Society
- JS Foster
- Kachemak Bay National Estuarine Research Reserve
- King County Department of Natural Resources
- Los Angeles Regional Water Quality Control Board
- Maryland Chesapeake Bay National Estuarine Research Reserve
- Maryland Department of Natural Resources
- Massachusetts Water Resource Authority
- Monterey Bay Aquarium Research Institute
- Mote Marine Laboratory
- Narragansett Bay National Estuarine Research Reserve
- Narragansett Bay National Estuary Program
- NOAA Fisheries
- NOAA Pacific Marine Environmental Laboratory
- Ocean Systems Test and Evaluation Program (NOAA / NOS / CO-OPS)
- Oil Spill Recovery Institute
- Old Dominion University
- Oregon State University
- Padilla Bay National Estuarine Research Reserve
- San Francisco State University, Romberg Tiburon Center
- Skidaway Institute of Oceanography
- Smithsonian Environmental Research Center
- South Slough National Estuarine Research Reserve
- Texas A&M University Geochemical & Environmental Research Group
- United States Environmental Protection Agency
- United States Geological Survey
- University of Alaska Fairbanks
- University of Connecticut
- University of South Carolina and North Inlet - Winyah Bay National Estuarine Research Reserve
- University of Toledo / Lake Erie Center
- University of Washington
- Virginia Department of Environmental Quality
- Virginia Institute of Marine Science

Note: Question 1 was a request for participants' names, organizations, and email addresses, and Question 18 asked if participants wanted to receive results of the survey.

V. The following section represents the survey questions and the percentage of respondents who selected each option.

2. Which of the following best represents the activity for which salinity data are used? CHECK ONLY ONE ANSWER

	Response Percent	Response Count
Research	**64.8%**	35
Resource management	7.4%	4
Regulatory compliance / permitting	3.7%	2
Wastewater treatment	0.0%	0
Aquaculture	0.0%	0
Environmental Health	18.5%	10
Other (please specify)	5.6%	3
answered question		**54**
skipped question		**0**

3. Which of the following represent the environment in which salinity data are collected? CHECK ALL THAT APPLY

	Response Percent	Response Count
Bluewater / marine	29.6%	16
Coastal / near shore	**75.9%**	41
Shallow water (< 10 meters depth)	68.5%	37
Intermediate depths (10 – 100 meters)	59.3%	32
Deep water (> 100 meters depth)	37.0%	20
Estuarine	72.2%	39
Rivers / lakes / freshwater wetlands	33.3%	18
Industrial (e.g., aquaculture operations, water and wastewaster treatment, etc.)	1.9%	1
Other (please specify)	1.9%	1
answered question		**54**
skipped question		**0**

4. Which of the following describes how salinity data are used? CHECK ALL THAT APPLY

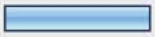
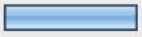
	Response Percent	Response Count
Description of the aquatic environment	**87.0%**	47
Hydrographic surveys	48.2%	26
Calculations of geostrophic flows	20.4%	11
Identifying and tracing water masses	64.8%	35
Calculation of water residence times	37.0%	20
Estimates of freshwater/seawater mixing	61.1%	33
Used as a parameter for other chemical determinations (e.g., Dissolved inorganic carbon, dissolved oxygen)	48.2%	26
Density calculations for stratification	61.1%	33
Estimates of vertical and horizontal mixing	44.4%	24
Other (please describe briefly)	11.1%	6
	answered question	**54**
	skipped question	**0**

5. In what form do you want salinity data presented? CHECK ONLY ONE ANSWER

	Response Percent	Response Count
Practical salinity unit (psu)	**65.4%**	34
Mass / parts per thousand (ppt)	21.2%	11
Mass / milligrams per liter (mg/L)	3.9%	2
Electrical conductivity / micro Siemens per cm (μS/cm)	9.6%	5
	answered question	**52**
	skipped question	**2**

6. What is your most common sensor application? CHECK ALL THAT APPLY		
	Response Percent	Response Count
Salinity sensor as part of a suite of water quality instruments	**90.6%**	48
Salinity sensor as stand-alone instrument	13.2%	7
answered question		**53**
skipped question		**1**

7. What is your most common sensor application? CHECK ONLY ONE ANSWER		
	Response Percent	Response Count
Hand-held / portable sensors for spot measurements	14.8%	8
Used for depth profiling	**37.0%**	20
Deployed sensor on remote platforms for continuous in-situ monitoring	**37.0%**	20
Flow-through system on a vessel for periodic surveys, transects, etc.	1.9%	1
Flow-through system on a vessel in long-term use (e.g., ferry)	3.7%	2
In-line monitoring for water treatment systems	0.0%	0
Other (please describe briefly)	5.6%	3
answered question		**54**
skipped question		**0**

8. What is the typical range of salinity for this application? CHECK ALL THAT APPLY PPT		Response Percent	Response Count
0 – 1 ppt		11.5%	6
0 – 10 ppt		9.6%	5
0 – 35 ppt		23.1%	12
5 – 15 ppt		11.5%	6
15 – 30 ppt		21.2%	11
30 – 35 ppt		15.4%	8
0 – 1 psu		1.9%	1
0 – 10 psu		3.9%	2
0 – 35 psu		21.2%	11
5 – 15 psu		9.6%	5
15 – 30 psu		**25.0%**	13
30 – 35 psu		19.2%	10
Other (please specify)		7.7%	4
	answered question		**52**
	skipped question		**2**

8. Others:

Only three participants responded that they were interested in salinity measurements outside of the ranges provided.

9. What level of accuracy do you require for this application? CHECK ONLY ONE

	Response Percent	Response Count
+/- 1 ppt	3.8%	2
+/- 0.1 ppt	**26.4%**	14
+/- 0.01 ppt	9.4%	5
+/- 0.001 ppt	3.8%	2
+/- 1 psu	1.9%	1
+/- 0.1 psu	15.1%	8
+/- 0.01 psu	17.0%	9
+/- 0.001 psu	9.4%	5
Other (please specify)	13.2%	7
	answered question	**53**
	skipped question	**1**

10. Are your current sensors: CHECK ONLY ONE

	Response Percent	Response Count
Primarily commercial products	**98.1%**	51
Primarily designs you developed yourself	0.0%	0
A combination of both	1.9%	1
	answered question	**52**
	skipped question	**2**

11. In which of the following areas does the in situ salinity sensor that you are currently using have significant limitations, not lived up to specifications or expectations, or does not meet your needs. CHECK ALL THAT APPLY

	Response Percent	Response Count
Range / detection limits	10.3%	3
Accuracy (Accuracy is the combination of bias and precision of an analytical procedure, which reflects the closeness of the measured value to the true value.)	24.1%	7
Precision (Precision is the measure of the degree of agreement among replicate measurements of a sample, usually expressed as a standard deviation.)	13.8%	4
Sampling interval / frequency	3.5%	1
Reliability (Reliability is the measure of the ability to maintain integrity of the instrument and data collections over time.)	6.9%	2
Operating life	10.3%	3
Operating pressure / depth range	3.5%	1
Calibration life	27.6%	8
Automatic calibration	24.1%	7
Ease of calibration	**31.0%**	9
Real-time sensor data display and/or analysis	13.8%	4
Off-sensor telemetry	6.9%	2
Input / output interfaces (e.g., computers, alarms, to other sensors or equipment etc.)	10.3%	3
Packaging	6.9%	2
In-field maintenance	24.1%	7
Quality of product handbook / documentation	3.5%	1
Cost	**31.0%**	9
Other	17.2%	5
If selected any areas, what were the specific issues that had significant limitations or did not live up to specifications or expectations?		14
	answered question	**29**
	skipped question	**25**

11. Explanation:
The majority of respondents listed increased servicing and maintenance intervals due to biofouling as their primary issue. Several participants listed difficulty with software as a shortfall. Whereas calibration cost was seen as a deterrent for two salinity sensor users, most respondents did not list this as being problematic. Others noted excessive power consumption and the unavailability of interchangeable cable lengths for hand-held remote units.

12. How important are the following characteristics to you when using salinity sensors in the field? Please enter a value between 1-5 for each box, where:

	Not at all important		Somewhat important		Very important	Rating Average	Response Count
Range / detection limits	0.0% (0)	6.3% (3)	12.5% (6)	35.4% (17)	**45.8% (22)**	4.21	48
Accuracy (Accuracy is the combination of bias and precision of an analytical procedure, which reflects the closeness of the measured value to the true value.)	0.0% (0)	4.1% (2)	2.0% (1)	32.7% (16)	**61.2% (30)**	4.51	49
Precision (Precision is the measure of the degree of agreement among replicate measurements of a sample, usually expressed as a standard deviation.)	0.0% (0)	4.2% (2)	0.0% (0)	39.6% (19)	**56.3% (27)**	4.48	48
Sampling interval / frequency	2.1% (1)	4.2% (2)	**56.3% (27)**	25.0% (12)	12.5% (6)	3.42	48
Reliability (Reliability is the measure of the ability to maintain integrity of the instrument and data collections over time.)	2.1% (1)	0.0% (0)	0.0% (0)	12.5% (6)	**85.4% (41)**	4.79	48
Operating life	0.0% (0)	2.0% (1)	20.4% (10)	36.7% (18)	**40.8% (20)**	4.16	49
Operating pressure / depth range	14.3% (7)	18.4% (9)	**38.8% (19)**	22.4% (11)	6.1% (3)	2.88	49
Calibration life	0.0% (0)	4.1% (2)	18.4% (9)	**44.9% (22)**	32.7% (16)	4.06	49
Automatic calibration	14.6% (7)	22.9% (11)	**27.1% (13)**	25.0% (12)	10.4% (5)	2.94	48
Ease of calibration	4.2% (2)	16.7% (8)	20.8% (10)	**33.3% (16)**	25.0% (12)	3.58	48
Real-time sensor data display and/or analysis	8.2% (4)	26.5% (13)	18.4% (9)	**28.6% (14)**	18.4% (9)	3.22	49
Off-sensor telemetry	19.1% (9)	**29.8% (14)**	23.4% (11)	19.1% (9)	8.5% (4)	2.68	47
Input / output interfaces (e.g., computers, alarms, etc)	8.5% (4)	29.8% (14)	23.4% (11)	**34.0% (16)**	4.3% (2)	2.96	47
Packaging	18.8% (9)	25.0% (12)	**29.2% (14)**	25.0% (12)	2.1% (1)	2.67	48
In-field maintenance	8.3% (4)	12.5% (6)	18.8% (9)	**39.6% (19)**	20.8% (10)	3.52	48
Product support / warranty / vendor reputation	0.0% (0)	6.3% (3)	16.7% (8)	**41.7% (20)**	35.4% (17)	4.06	48
Quality of product handbook / documentation	2.0% (1)	16.3% (8)	18.4% (9)	**36.7% (18)**	26.5% (13)	3.69	49
Cost	0.0% (0)	10.2% (5)	**34.7% (17)**	**34.7% (17)**	20.4% (10)	3.65	49
					Other (please describe briefly)		3
					answered question		**49**
					skipped question		**5**

13. How important are the following characteristics to you when deciding which salinity sensor(s) to purchase? Please enter a value between 1-5 for each box, where:

	Not at all important		Somewhat important		Very important	Rating Average	Response Count
Range / detection limits	0.0% (0)	2.3% (1)	9.1% (4)	**45.5% (20)**	43.2% (19)	4.30	44
Accuracy (Accuracy is the combination of bias and precision of an analytical procedure, which reflects the closeness of the measured value to the true value.)	0.0% (0)	4.7% (2)	4.7% (2)	30.2% (13)	**60.5% (26)**	4.47	43
Precision (Precision is the measure of the degree of agreement among replicate measurements of a sample, usually expressed as a standard deviation.)	2.3% (1)	2.3% (1)	2.3% (1)	39.5% (17)	**53.5% (23)**	4.40	43
Sampling interval / frequency	0.0% (0)	7.0% (3)	**48.8% (21)**	34.9% (15)	9.3% (4)	3.47	43
Reliability (Reliability is the measure of the ability to maintain integrity of the instrument and data collections over time.)	2.4% (1)	0.0% (0)	0.0% (0)	21.4% (9)	**76.2% (32)**	4.69	42
Operating life	0.0% (0)	4.7% (2)	16.3% (7)	**44.2% (19)**	34.9% (15)	4.09	43
Operating pressure / depth range	14.0% (6)	16.3% (7)	**39.5% (17)**	25.6% (11)	4.7% (2)	2.91	43
Calibration life	2.3% (1)	4.7% (2)	23.3% (10)	**41.9% (18)**	27.9% (12)	3.88	43
Automatic calibration	14.0% (6)	27.9% (12)	**30.2% (13)**	18.6% (8)	9.3% (4)	2.81	43
Ease of calibration	7.1% (3)	16.7% (7)	23.8% (10)	**28.6% (12)**	23.8% (10)	3.45	42
Real-time sensor data display and/or analysis	14.0% (6)	14.0% (6)	**27.9% (12)**	25.6% (11)	18.6% (8)	3.21	43
Off-sensor telemetry	16.7% (7)	**28.6% (12)**	**28.6% (12)**	21.4% (9)	4.8% (2)	2.69	42
Input / output interfaces (e.g., computers, alarms, etc)	12.2% (5)	22.0% (9)	29.3% (12)	**31.7% (13)**	4.9% (2)	2.95	41
Packaging	19.0% (8)	19.0% (8)	**35.7% (15)**	23.8% (10)	2.4% (1)	2.71	42
In-field maintenance	7.3% (3)	9.8% (4)	24.4% (10)	**41.5% (17)**	17.1% (7)	3.51	41
Product support / warranty / vendor	2.3% (1)	9.3% (4)	7.0% (3)	**44.2% (19)**	37.2% (16)	4.05	43
Quality of product handbook / documentation	2.3% (1)	14.0% (6)	18.6% (8)	**39.5% (17)**	25.6% (11)	3.72	43
Cost	0.0% (0)	2.3% (1)	27.3% (12)	**43.2% (19)**	27.3% (12)	3.95	44
					Other (please describe briefly)		5
					answered question		**45**
					skipped question		**9**

14. Relative to the above (Questions #11 and #12) sensor system characteristics, are any of your sensor needs or requirements "non-standard" or custom?

	Response Percent	Response Count
No	87.2%	41
Yes (please describe briefly)	12.8%	6
answered question		47
skipped question		7

14. Explanation:

Participants listed the following sensor needs or requirements as being "non standard" or "custom": **a)** the need for output to be integrated to dissolved oxygen and temperature readings to calculate saturation percentage, **b)** the need for decreased power requirements when using instruments to power external voltage channels, **c)** higher range detection, **d)** the use of a suite of water quality instruments to conduct long term monitoring in an environment that subjects the instruments to high sediment rates, a large salinity range, high nutrients, and extreme biofouling, and **e)** the need for a standardized sensor interface that allows for interchangeability between different sensors and monitoring suites.

15. Do you plan on acquiring new commercial sensors within the next 2 years?

	Response Percent	Response Count
Yes	74.0%	37
No	26.0%	13
answered question		50
skipped question		4

16. If yes, will you consider a different sensor type than the one you are currently using to measure in situ salinity?			
		Response Percent	Response Count
Yes: please explain why:		51.3%	20
No: please explain why not:		51.3%	20
	answered question		39
	skipped question		15

16. Explanation:
The majority of respondents who answered "yes", cited the following reasons as to why they would consider a different sensor type: **a)** interest in better product with new technology, **b)** lower maintenance costs, **c)** integration into telemetered mooring systems, **d)** long-term moored application, **e)** improvements in biofouling technologies, and **f)** compatibility with existing instruments i.e. software, datasondes, etc.

The majority who answered "no" cited the following reasons: **a)** currently under contract with manufacturer, **b)** content with current instrument(s), **c)** desire to maintain consistent technologies, **d)** existing sensor is part of a standardized national network, **e)** software is specific to current instrument, **f)** and cost and time involved for new instrument training exceeds foreseen benefits of purchasing a new instrument.

17. Based on your experience with in situ salinity sensors, are there 1) any shortfalls or modifications (for your specific application that you noted above) in current designs, or 2) any additions you'd like to see in future designs?		
		Response Count
		26
	answered question	26
	skipped question	28

17. Explanation:
Participants cited the following shortfalls, modifications, and desired future alterations: **a)** an instrument capable of measuring interstitial salinity in wetlands was viewed as desirable, **b)** a real-time water column pressure / acoustic solution to the "bulky density obs for vessel draft calculation currently employed", **c)** lower cost units, **d)** the ability to better ground-truth a reading, **e)** greater accuracy for longer deployment periods, **f)** better anti-fouling technologies, **g)** improved software that enables realtime telemetry of data for realtime website reporting with all sensors broadcasting, **h)** software that produces javascript files of data, enabling websites to read updated data files, **i)** improved interface, **j)** the alignment of conductivity and temperature so that accuracy of salinity is optimized, **k)** improved instrument manuals that are easier to understand, **l)** standardized default settings among different manufactured instruments, **m)** more robust sensors that are less vulnerable to impact, and **n)** sensors with faster response times for use on towed underwater vehicles. The foremost cited shortfall noted by instrument users was biofouling.