U.S. DEPARTMENT OF COMMERCE

+ + + + +

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)

HYDROGRAPHIC SERVICES REVIEW PANEL

+ + + + +

PUBLIC MEETING

+ + + + +

THURSDAY
APRIL 20, 2017

+ + + + +

The Hydrographic Services Review Panel met in the Kimpton Hotel Monaco, Paris Ballroom, 1101 4th Avenue, Seattle, Washington, at 8:30 a.m., William Hanson, Chair, presiding.

MEMBERS PRESENT

WILLIAM HANSON, HSRP Chair
JOYCE E. MILLER, HSRP Vice Chair
DR. LAWSON W. BRIGHAM
LINDSAY GEE
KIM HALL
EDWARD J. KELLY
CAROL LOCKHART
DR. DAVID MAUNE
SCOTT R. PERKINS
CAPTAIN SALVATORE RASSELLO
EDWARD J. SAADE
SUSAN SHINGLEDECKER
GARY THOMPSON

NON-VOTING MEMBERS
ANDY ARMSTRONG, Co-Director, NOAA/University of New Hampshire Joint Hydrographic Center
JULIANA BLACKWELL, Director, National Geodetic Survey, NOS
RICH EDWING, Director, Center for Operational Oceanographic Products and Services, NOS
DR. LARRY MAYER, Co-Director, NOAA/University of New Hampshire Joint Hydrographic Center

STAFF PRESENT
REAR ADMIRAL SHEP SMITH, HSRP Designated Federal Official; Director, Office of Coast Survey
RUSSELL CALLENDER, Assistant Administrator, NOS
MIKE ASLAKSEN, Chief, Remote Sensing Division, NGS
MARK ARMSTRONG, Geodetic Regional Advisor, NOAA/NGS
GLENN BOLEDOVICH, Policy Director, NOS
CAPTAIN RICK BRENNAN, Chief, Hydrographic Surveys Division
JIM CROCKER, Chief, Navigation Services Division
BEN EVANS, Chief, Coast Survey Pacific Hydrographic Branch
RACHEL MEDLEY, Acting Deputy Hydrographer
LYNNE MERSFELDER-LEWIS, HSRP Coordinator
ROLIN MEYER, Branch Chief, Field Operations Division, CO-OPS
TRAVIS NEWMAN, Marine Chart Division
AMANDA PHELPS, Budget and Program Analyst, OCS
JIM RICE, NOAA/NOS
E.J. VAN DEN AMEELE, Chief, Coast Survey Development Laboratory

SPEAKER
MARTEN HOGEWEG, Senior Project Manager, Esri, Inc.

CONTENTS

Overview and discussion of day two 5

Technology Working Group Session and Presenters
Ed Saade and Lindsay Gee 13
HSRP Technology Working Group

Visualization R&D at the Joint Hydrographic
Center/Center for Coastal and Ocean Mapping
Dr. Larry Mayer and Capt. Andy Armstrong 16

Data as the 5th Modality for 21st Century Ports
Marten Hogeweg 72

An Introduction to Bathymetric Lidar:
Sensors, Capabilities and Limitations
Carol Lockhart 113

Review of Technology Working Group 167
issue paper and discussion
Carol Lockhart

Public Comment Period. 189

Technology Transfer Discussion Paper 198
Ed Saade

Discussion and recap on Tech Working 202
Group session

HSRP Planning and Engagement Working 213
Group: four issue papers

HSRP Member Discussion 233

Review of Day and Meeting, Actions, Closing
Remarks. 379

Adjourn. 383

P-R-O-C-E-E-D-I-N-G-S

(8:31 a.m.)

VICE CHAIR MILLER: Good morning, and welcome to the third day of the Hydrographic Services Review Panel meeting in Seattle, Washington. I'm Joyce Miller, the Vice Chair of the Committee.

Bill Hanson and Admiral Smith, Admiral Smith had to go back to Washington, so Rick Brennan is sitting -- the Deputy DFO is sitting in for Admiral Smith. And Bill had another meeting actually in Everett this morning. And he will be back this afternoon for our final deliberations.

Are there any recent additions that we haven't had introduce themselves? Is there anyone new here today that hasn't been here the last two days?

MR. KEARNS: Hi there. My name is Tim Kearns. I'm with a company called OceanAero based out of San Diego making unmanned drones.

And I've been involved in the

hydrographic community for most of my career. So I also live in Seattle, which is why I decided to attend today. I hope that's okay.

MS. MERSFELDER-LEWIS: Anybody else not introduce yourselves yet?

VICE CHAIR MILLER: Okay, let's get started then with the meeting. First thing on the agenda this morning, and I'm going to do it a little bit differently than I did yesterday or than we did yesterday.

Would any of the Panel members like to either summarize or bring out important points that we learned in yesterday's session? I would add that, in the afternoon that was not a public session, we had a lunch speaker from the government. She's the Government Relations Director of the Pacific Northwest Waterways Association, Heather Stebbing. And she gave us a briefing, a short briefing at lunch.

And then in the afternoon, we visited the Coast Guard Operations Center for Puget Sound, and the Holland America, Princess, and I believe P&O Australia lines, a brand new command center in downtown Seattle.

Are there, the Panel members, is there anyone who would like to bring out any important points from yesterday?

MEMBER MAUNE: I can. We reviewed, we had a session on the issue papers yesterday morning, and we decided that the Precision Nav paper would have a major rewrite and that Kim is going to work with other people here to come up with a new Precision Nav paper.

We accepted the paper on recreational boating with minor changes by Susan, and that this afternoon we will discuss the remaining two issue papers.

VICE CHAIR MILLER: Thank you, Dave. Anyone else from yesterday's results?

MEMBER PERKINS: Joyce, if I could add to that. We did set a goal -- and I won't call it a deadline; I'll call it a goal -- of having that rewrite of that paper done in advance of the committee convening at our next meeting.

VICE CHAIR MILLER: Yes. I would, just for the information of the audience, one of the comments we got from the commanding officer at the US Coast Guard base was the value of our Navigation Response Teams, which are six small boats positioned around the country.

Every time we come into one of these areas, people sing the praises. Seattle probably hasn't used them much because you don't have many tsunamis or hurricanes here. But we once again heard that.

And I think it's important, and I think it's an important point how well NOAA does that. And I think it's something that NOAA should be proud of and advertise more.

VICE CHAIR MILLER: Kim?

MEMBER HALL: I'm sure Sal will agree with me. When we got to see the new center, it's pretty neat. But it was also interesting just to see how many overlays they have for information, what the commercial industry is doing with the types of information that are produced by NOAA and other hydrographic offices.

And some of the needs when you look at it, the choke points where these ships go through and contours and other things that they would really need that would help ensure safety navigation, not just around the US but around the world. So I think that was kind of a really cool, practical application of the data that NOAA and others collect.

VICE CHAIR MILLER: Thank you. Lindsay?

MEMBER GEE: So it was very interesting to see, I think, the difference between the Coast Guard. I was very focused on one particular issue of bringing the ships in. And so they had actually gone almost the opposite way and stripped out from the NOAA data which is essential to just focusing on the tasks they have.

So that's interesting to see different users of the data. They're prepared I think in their new center they said bring in the other oceanography and currents and tides, and they just haven't done that yet. So that was interesting.

I would also like to comment on the morning session. I thought it was great to have the local, some of the earlier ones were a little bit technical, I guess. I enjoyed them, it was about datums and things like that. I thought that was really interesting to me, maybe not to the whole Panel, but I thought that was worthwhile. And to see what people were doing with data and that kind of the -- Dr. MacCready I think tied into the NANOOS the day before and those sorts of things.

One of the ones I'm interested to see for the future, we've sort of talked about datums and that sort of thing. But I think tying in more the VDatum, maybe we need to think about more of that in the future. The tie between the NGS cohorts and those --

VICE CHAIR MILLER: That might be a good topic, Juliana, for a future meeting, especially since we have a lot of new members. We've had some datum topics before, but we have new members. And I for one will freely admit that I don't understand them well. Lawson?

MEMBER BRIGHAM: Yes, I mean you showed the VTS, which is a very focused -- it's not necessarily a command center. It is in a way for the safety here.

But you didn't see the real Coast Guard command center that covers the whole region. And so you saw a very focused and important new marine safety environmental protection tool, new, three decades old.

My comment for the command center, true command center of the cruise ship industry, it points to the value and the importance of IHO where the Admiral is going today.

The International Hydrographic Organization, because all of, kind of most of the maps we saw were all foreign -- charts we saw were all foreign. And so it's the international effort.

And then, of course, whoever's the hydrographer of the United States, what he or she brings into the system from even this meeting, those issues are really all international.

VICE CHAIR MILLER: Thank you, Lawson. I would kind of come back on a couple things we've heard. I think one of the overlying topics of this meeting for me has been the importance of NOAA data, the need for more NOAA data in many cases, but also the really critical need to give access to data in a rational and hopefully single point manner.

To me, I've heard that, whether it was the modeler or the guy trying to do land surveys or other people that we've heard, but we've heard data, data, data over and over again.

MEMBER KELLY: Joyce, I would echo and second that. The thing I've been very impressed with at this meeting is the diverse range of opportunities to acquire data.

We've heard an awful lot from crowdsource people, we've heard people from

NANOOS. There were a lot of people creating and using a lot of data that isn't necessarily incorporated into the NOAA inventory.

And I think that might be something with the increased technological capabilities and the fast pace of the internet, we need to broaden the way we can acquire and make use of some of that data. Because some of the kind of flashy stuff that they're doing at the Vessel Command Center, et cetera, shows some of the potential of what can be done with this powerful data, and we really need to find better ways to reach out and get that data into our inventory for use.

VICE CHAIR MILLER: Okay. So if there are no further comments, the next item on our agenda is HSRP has a technology working group. It was formed two meetings ago or three. And it's led by Mr. Ed Saade of Fugro and Lindsay Gee, who is a private contractor.

MEMBER GEE: Sometimes unemployed.

VICE CHAIR MILLER: So we're going to have a variety of topics from several different members, and Ed and Lindsay will introduce the speakers. Go ahead.

MEMBER SAADE: Lindsay's going to take the lead on this. I just wanted to thank the Panel for allowing this dedicated session. It's pretty exciting for me, and I think we're going to keep that theme of diversity going along with the different types of topics and the different applications. So thanks, everyone, for this opportunity.

MEMBER GEE: Thanks. I think one of the things we've seen, and the reason the technology group came to -- the technology kind of is the underpinning now of most of what we do, and we've seen that across the discussions both over the last couple of days.

And I think our technology group has been focused over the time mostly on the coast survey side of the business, but thinking about it, and I spoke to Gary this morning, in fact, the first issues paper that had nothing to do with the technology group, but we'll take part of, that was Gary's paper on the new datum. And so that really is an underpinning of part of the infrastructure.

And I think there's lots of talk about infrastructure around. I think people think of hard stuff, dredging and all of those things.

But as technology becomes more important, the IT infrastructure and that, we need to somehow make sure that that gets included as part of the infrastructure discussion.

And I'm not sure that message always gets through, but I think we've got to find ways to work that so that message does really, and people understand that the infrastructure and IT is just as important now as the hard physical infrastructure we have.

We're going to just briefly, summary just for this morning. We've got three presentations. One was, I think we didn't have Larry and Andy give a presentation as the directors of the JHC and CCOM this time.

But we discussed with them, and

Larry's going to present on some of the visualization R&D at JHC/CCOM, then followed by Martin who's been working with the Rotterdam Port project, and it's something that's been discussed, and we thought it was worthwhile to hear that from someone that was deeply involved in that, followed by Carol.

We're trying to, because part of the technology group I think it was to bring some of the experience outside and then address what's already happening inside. No, we don't as a Panel know all of those things that are happening in NOAA, so we've tried to also address that.

And there was a request as we went through from the Panel, some update about different technology subjects. Carol is going to do some introduction on the bathymetric LIDAR because she is an expert in that area.

One of the things I think the benefits we saw from the Panel the other day with the Rose Point and the charting with Travis and Jeff Siegel from ActiveCaptain, it was a great discussion I thought, and there was plenty of time for discussion.

We would hope we can do that, and what we're presenting will be of interest to generate that discussion. So of course, to start that off, I think one of the people that always generates good discussion and has the latest technology/interesting things to show us is Larry.

He's one of our Panel, so we don't need to introduce him. And he's going to discuss the visualization research.

DR. MAYER: I'm not going to sit. I have to stand. And I thank the working group for the opportunity to talk to you. Last time, well I guess I have the --

No, I have my own. Tools of the trade. You get 30 years of using one thing, but it's not changing.

So last time Andy and I gave an overview, a very brief overview of the lab, the Center for Coast and Ocean Mapping or Joint

Hydrographic Center in the NOAA context. And we talked about, just again, a very high level what we did, the kind of different topics that we discuss.

What we decided last time is that we should through the Technology Working Group come back and try to address eventually a number of the areas that are relevant. And this time, we talked about coming back and doing visualization.

There's one new event since that last presentation that I want to let you know about. We're very, very excited about it, and that's that the university has started now a Bachelor of Science in Ocean Engineering program that will be connected to our program, too.

We look at it as a great feeder. Our program has been a master's and PhD level program, just a graduate program. But there's a very large bit of construction going on attached to our center. And I think when you guys come out there in September, hopefully I think that should be completed, and you'll get to see it.

One of the nice things is we'll have a nice new big 80-85 seat theater presentation room. So I think if you guys really grow, it could be very comfortable for you there.

So as I said, we gave an overview of many, many of the different topics that we address at the center, but this time we've been asked to just focus on one of them in a little more depth, and that's the issue of visualization and with COF, the Chart of the Future.

We've had for a number of years a research component of our work, trying to look at what the Chart of the Future might be. And I think this is remarkably relevant to the discussions we had on Tuesday, and the neat discussion it led to about what the Chart of the Future might look like.

We have a very talented group of visualization people in our lab. They are people who come from computer science backgrounds and psychology backgrounds too. And they really focus on fundamental principles of human-computer interaction.

And so what they try to do is not just say that would be neat to develop something that looks like this; they do studies of individuals to try to figure out what is the most appropriate way to show something and how will people perceive the information you're trying to send to them in the best possible way.

And we're very fortunate also to have folks like Rick when he was a graduate student and Andy constantly there, people who are mariners. And we try to get input from them, although sometimes Andy and I disagree, and that's very, very healthy.

And you heard some of that disagreement on Monday. And you'll see, I'll push and I'll push and I'll push, but I certainly understand that what we're going to show is not relevant for all sorts of navigation.

Sal and I have been talking about that. We have to think about the individual application. But we just want to be sure, because all of these technologies are evolving, that we don't just stick our head in the sand and ignore it and say we'll keep doing it this way because we've always done it this way.

Let's look at the opportunities, and this is what we're hoping from the Panel and everybody else, to get some feedback about what ways might be appropriate and what aren't, and that helps us direct our research, too. So we're looking very forward, very much forward to that discussion that we'll have at the end.

We have a number of tools in our kit beyond just the smart minds of some of the people. We have a very large 180 degree wrap-around display, and I'll show you a little later a new device we've built which is an augmented reality, virtual reality simulator that very much looks like a, you know, I'm sure many of you have been to the spectacular bridge simulators with the $800 to $1000 construction as opposed to a several million dollar construction. I'll show you an example of that in a few minutes.

As I said --

MEMBER GEE: Not 800,000.

DR. MAYER: No, $800 to $1,000. Oh yes, no, no. it's based on a laptop, that's all. And a pair of goggles. Thank you. If I slurred that, that was --

Like I said, particularly Colin, Colin Ware, the director of our Visualization Lab, he does these human-computer interaction studies. And he has all kinds of test cases and things like that.

Goes through trying to find out what the most appropriate way to depict information is, and he's been working a lot with vectors, current information, wind barbs. He's got a new kind of wind barb, I think that's being very effective.

And from these studies he writes papers in journals about this kind of stuff. And here's one for looking at different ways to something we haven't talked about much. How do we -- bathymetric uncertainty. This is going to be very, very critical, I think, as we go along.

So again, he's doing studies. This one hasn't concluded yet, but in terms of the current barbs and wind barbs, I think he has come up with some very, very nice things, and we're looking at now the next generation, a wide range of applications, weather display.

And this is even our last Administrator was so impressed with this, she has it outside of her -- or had it outside of her office in terms of just much, much, much more using animation when possible and using appropriate shapes to features and visualization tricks to show the interaction.

You like that? That's what I like to hear. But if you don't like it, I like to hear that, too, because this is what's important.

Yes, so you can, again, because we're totally in a digital, database-driven regime, you can actually, you can click any point and interrogate for the detailed information, and you can change the display to meet your particular need.

And so this now from a weather application is being now applied to our maritime applications. This is actually work we were doing with the Navy for enhanced portrayal of surface currents and wave conditions, and even in a quasi little 3-D display because the submarines are very, very particular about when their periscope is going to be visible or not.

And so there's been software built that can be so diminished that it could be transmitted to a submarine with very, very little bandwidth. And so they can get a display of their visibility in a particular wind and wave condition.

MEMBER RASSELLO: Very, very useful.

DR. MAYER: Very useful. Write that down, write that down.

(Laughter.)

DR. MAYER: Okay, well, boy. Well, we'll get to the end where he's going no, no, no. I'm starting with the easy stuff. And this has been picked up with NOAA's nowCAST. And much of this, you see the traditional wind barbs in nowCAST, and now --

MR. ARMSTRONG: NowCOAST.

DR. MAYER: NowCOAST, yes excuse me, I'm sorry. And now the enhanced wind barbs in nowCOAST. And the same with surface currents. The old display in -- oh, I'm sorry there. Martin, I'm going to blind you. You didn't realize it but the laser went right -- I'll keep this in my pocket.

The old display of vectors for surface currents and the new enhanced one now in nowCOAST. So again, this is actually being put into NOAA application where we can.

Traditionally, what the focus of our lab visualization efforts have been on for many, many years has been the sea floor, both the bathymetry and the backscatter. And I think we were early, early developers of tools to display the sea floor and in 3-D.

But really the effort now has gone

beyond that, and we're going from 3-D to 4D. And so we're looking at both temporal changes in the sea floor, and temporal changes in the water column because our sonars are now letting us look in the water column, and we've developed a number of applications to do that.

And I don't know what's coming up next because there's, I don't ever see the next one. So one of them has been looking at marine mammals, putting tags on marine mammals.

We don't do that tagging. Another part of NOAA does that tagging. Those tags are recovered. Those tags have a heave, pitch, roll sensor, depth sensor. They also have a hydrophone actually on them. So there's a sound recording on that too.

And then being able to replay the behavior of whales. This is sped up a little. Really quite intriguing. These circular loops, these are called bubble feeding behaviors.

They find a school of fish, I think sand lance, this is actually a fishery sonar up here, the vertical track and looking at what they're feeding on.

But then they'll go do this spiral around the school of fish blowing bubbles. It acts as a net, and it traps them, come up to the surface, slap the surface and stun them, and then come up with their mouth open. Sam?

MR. DEBOW: Is that an ME70 sonar?

DR. MAYER: It's an EK60. EK60 is the vertical sonar. The traditional fisheries single beam sonar, and it's a split beam, but I'll show you the next generation EK80 in a little while.

This was actually an interesting -- this was the first time they ever tagged two whales simultaneously. And it turns out one was a male, one was a female.

And they were wondering if they worked collaboratively to feed. And it turns out that one did all the work, and the other mooched off of that.

VICE CHAIR MILLER: Which one was it?

DR. MAYER: I know, but I'm not going

to say. I always let you guess.

(Laughter.)

DR. MAYER: I always let you guess. Okay, so here's again an application that drifts into the broader needs of NOAA but not necessarily the hydrographic one. That same visualization of the water column, it really was developed towards the purpose of fish and marine fisheries and looking at wide behavior.

But when the first deepwater water column-capable sonar was put on the Okeanos Explorer, it was coming in on its sea acceptance trial, its test trip to San Francisco. And off the coast of, oh Mendocino I think it was, ran over a feature that showed up in the water column.

Again, we applied our visualization techniques to it to see what it was. And what it was was a 1,400 meter mile high gas seep coming out of a fault there or a slump.

You can see the area where it slumped. And they came back. They had to get into port but came back a week later to see if it was still there and found, yes, it was still there. And there was a long line of them along a fault scarp.

And it wasn't surprising. This is an oil and gas rich province. But what was surprising was the behavior of it, and I don't think anybody realized just how sensitive the multibeam would be to depicting it and depicting the behavior of the bubbles themselves.

And this has led to a huge area of research, both in our lab, in other labs, and has been picked up quite a bit by the industry. And I think Ed will talk about that at some time later.

This first depiction of that gas seep coming into California happened just a couple of months before Deepwater Horizon. And when Deepwater Horizon happened, we got a call from the White House, from the Office of Science and Technology Policy.

They called a meeting at the White

House, and they said they had a huge problem. That huge problem was the accounting, they didn't account for all the oil. They had the filming of the leak. They had measurements of the surface slip, but there was a lot of oil missing.

And they figured there was a deep plume, and they wanted to know -- they had the directors of several of the oceanographic institutes, could we help in trying to find the deep plume?

And so Admiral Smith, when he was a, I don't know what he was, commander at the time, and many other of our NOAA ex-students and students at the time, it was an amazing mobilization effort on the part of the NOAA crews, taking some of the hydrographic vessels and putting CTDs on them and putting fisheries echosounders on it, taking some of the fisheries vessels and putting extra stuff on it. And we all went out to try to acoustically map the deep plume.

And there were lots of issues in terms

of our being able to get on top of it. But once we were out over on top of it, whether we could see the plume of oil or not was not clear. But one thing we could clearly, clearly see was gas seeps and gas anywhere. And again, Ed will come back to the ramifications of that in the industry.

This picture depicts the very first time we were allowed over the Macondo well, the night that they capped it. I got a call. It was the scariest call I ever got in my life.

It was a call from the Secretary of Energy, Secretary Chu because I had been reporting to his working group every eight hours for a month or two by that time.

And he called me out of the eight hour sequence and said we're going to put the cap on the well tonight. We're worried that the integrity of the well is flawed and that there will be a blowout on the side.

And if that happens, we can't stop it. And that will just have to run up until the field depletes or until we put a relief well, which was going to take until October, November, many, many months.

And he said, but if we can capture it, if we can see that happening in the first five or six hours, we can pull the cap off and adjust things.

And he said, can you guarantee that if we put you right over the well, you'll see gas coming out? And that was a scary question. I thought so, but I asked all our smart people in the lab, all the acoustics people, and everybody said yes, yes, yes we could. And so they put the cap on and that's what we saw: we saw gas coming up.

And they pulled it off, and BP came back and said, no, that's not true. They said they don't know what they're doing. We demonstrated we know what we're doing in terms of the ability to identify targets.

They then came back, oh, well, maybe there's gas, because they put an ROV down there and saw a little leak. And they said, well, it's nitrogen. And then, finally, it was all resolved that it was -- it was methane just as we suspected, but it was a tiny, tiny leak and I guess that video has run through its -- can you just click that? Nicky, if you can click that video there, maybe?

But what it was, that is the cap, and it was basically -- yes there you go. Just click that. You'll see just a few bubbles a second. And that was nothing dangerous. They kept ROVs on that for the next nine months or so.

It never got bigger. It was a scratch on a metal to metal flange. But that's how sensitive the acoustics are for seeing that little amount of bubbles coming up.

PARTICIPANT: From the surface?

DR. MAYER: From the surface, from a surface ship. And every once in a while, this is hydrate. This is gas that turns into a frozen net, oil stain. A piece of that would break up, and we can even see those pieces breaking up.

The from the surface part was what BP -- BP tried to discredit us by saying they could never resolve those kinds of things to make it worth their while to put an ROV down.

And so they did an experiment. They sent three mud boats, three ROVs. They put a nitrogen extraction system 2,000 meters to the sea floor. And they challenged us to find them. They turned it on, turned it off, and we would be steaming over in a blind test.

And it was very funny because the Secretary, I know Secretary Chu is a Nobel laureate in physics, and he was asking all these technical questions. We said we could actually locate any seep to within 30 meters because of the split beam processing.

And Fugro said, no, it's an 11 degree beam, it's only 300 meters they can find it. And so with 300 meters, you can't put an ROV and find something.

And so the Secretary, this was all on the phone, he's saying, well, excuse me, BP, did

I say Fugro? Oh, sorry. Oh, thank you. I'm so glad you're here. That's the second one, yes, see.

MEMBER SAADE: It was our client, I swear.

DR. MAYER: So they probably spent a million dollars on that test. And the Secretary's saying, what's the beam width, and he's right. And he goes, I think you can locate it to within 12 meters.

And I said, well, that's probably true, Mr. Secretary, that's what the numbers show. He had done the calculations right there. I said but we were trying to be a little conservative so we rounded it up to 30 which is still a fine circle for an ROV to find something.

And so after this test, this several day test, upon returning we found every little seep, we found it every time they turned it on, every time they turned it off, and we located it within 12 meters, as the Secretary said.

So I later asked -- well I'll go with

that. Okay, this has some direct hydrographic applications, too. And some of the hydrographic applications are being able to look in the water column gives us a much, much more robust tracking of shoalest depth.

When we're mapping the sea floor, there tends to be a bottom tracker that's quite tight. But when we start being able to look at the water column data and see every little return, if we're clever enough in looking at those, we can really see lease depths on wrecks.

And this is a great time, can be a great time saver from a hydrographic perspective, where you can actually start picking up each mast and things like that.

And I know at least the UKHO has now accepted this kind of water column data for lease depths, and they don't go with a wire sweep or things like that on rigs.

MR. ARMSTRONG: And it's in our specs and deliverables now.

DR. MAYER: And it's in NOAA's, thank

you. I didn't want to say that because I didn't know. But I'm glad to hear that.

MR. ARMSTRONG: Put there by one of your grad students.

DR. MAYER: And exactly. And here was one of the NOAA students come down for her master's thesis and basically looked at this problem at the lab and did this study.

MEMBER GEE: And it's also been accepted worldwide. There are other hydrographic organizations, too.

DR. MAYER: This same kind of combination of looking at better ways to depict flow, but now in a 4-dimensional sense lets us tie into things like sediment transport models and look at coastal zones and what would happen, where would erosion -- within an appropriate model, where would erosion occur or not occur, and we can actually use this very much for decision-makers in terms of coastal planning.

I had another slide here which crashes the machine every time which showed Hurricane

Sandy, a series of, there have been now seven surveys.

One happened to happen the week before Hurricane Sandy where there were all the subway cars on an artificial reef off of Delaware. And we've been able to watch those subway cars move, erode, refill, break up, and now the sea floor turning to basically its normal state.

PARTICIPANT: I think the depth of water, too, is really near the subway --

DR. MAYER: Yes, 60 meters or so, yes. So quite a bit of action, even that deep. Yes, thank you. Thank you for pointing that out.

And then finally, and this is a place I never really thought I would see much use for, goggles that you actually see 3-dimension where the things I'm showing in 3-dimension, or really pseudo-3-dimension where you put a pair of stereo goggles on, you get to see that.

And one of the exercises we've been looking at now are looking at current models, but not just of the surface, now looking through the water column. So there are a number of current models out there that give multiple layers, up to 30 layers in the ocean.

And for things like Deepwater Horizon, it would have been fantastic for us to have it then, to use the current models to see which way a deep plume would be flowing. We had no, we were just sticking CTDs blindly down trying to find it.

But by following that model, and this is something I'm actually taking a picture here of what's being blurred because the goggles are showing it in true stereo. So you'll see Tom Butkiewicz who developed this with this. This is the NCOM model running.

And he puts what he calls a dye pole and I kept thinking about this magnetic dipole, but he meant D-Y-E, dye pole, a pole that you can put dye at any level, and you can see the current flow at each different level as we saw.

And here's for the first time, I really saw the value of being able to look at things in true 3-D. And we also did a model of this for Fukushima, looking at what would happen to the radioactive plume.

And we can give appropriate properties to the water mass, if they're oil-laden or whatever. So they have the proper buoyancy properties and will flow like that.

Another application for this kind of thing is for AUV or glider planning. You can now look at the full 3-dimensional water column structure and plan your route out.

And this is the kind of interesting thing at the lab. We have these kind of computer science geeks who are wonderful. And what Tom loves to do is develop these widgets. He doesn't care about the oceanography or anything like that.

He loves to develop widgets. And our job is to focus that energy on doing it in a way that serves our community. And so his, what he writes papers about is this interesting widget that he develops and then can plan out the route at different levels.

And then it will do an optimization calculation if it's an AUV or a glider. Does it have to fight against the current, with the current? What will the battery life be. And then you can sit there and in 3-dimensions drag and change the track to maximize the efficiency of the flight.

And so I've kind of avoided the hydrographic things, and now I'm going to get into dangerous territory. And again, not so much -- I guess our approach over the years for the Chart of the Future is to build incremental steps and not really address the true navigation issue but the aids to navigation.

So one of the things we started to do, and this is a lot of the work of Briana Sullivan, is to start to create really Digital Coast pilot. A coast pilot was a printed document.

And so what we created was a prototype that allows you to basically see the images in 3-dimensions, if you want, of the features. But you can click on the feature, go to the image, click on the image and go to the text description.

But I think most importantly in terms of Briana's contributions was her ways of going through the database that exists there which was very much a non-digital database and trying to turn it into a digital database that can easily be then visualized in a way like this.

And I think there's been very good cooperation. I think Andy knows better than I in terms of -- with the NOAA coast pilot community, in terms of interactions there. And it's really led to this thing which he calls the ChUM or the Chart Mashup which is again a way of going through and automatically extracting notice to mariners, things like that and getting them into a digital realm and a digital environment that's an interactive, easily updatable, easily displayable.

And I'll just, I'll let this run for a moment because it gives you some ideas of the different layers, including things that I know when we were working on the Gulf, the thing I was most amazed about is I was really, there was no kind of up-to-date record of where the platforms were.

That was kind of, we just had to look out the window all the time. And I was surprised about that. But this has, I guess there is somewhere distributed a platform --

Yes, yes. And again, I think there's been a very good interaction with the appropriate NOAA offices looking at this. And some of these ideas are being adopted. Andy, please?

MR. ARMSTRONG: Yes, that's right. And I think the Marine Chart Division kind of starting with Briana's work has made additional progress on this and now uses this approach with our weekly chart update web page on the charting coast survey website.

DR. MAYER: Okay. And so now I'm going to get to the final and probably most controversial part, and this is what's always frustrated me, and I come from a background as a geologist and a geophysicist and I always wanted to see and understand the sea floor.

And it's always this issue of when I see a chart, maybe that is by far the very most appropriate presentation for navigation, but there are many, many other applications, and there's so much stuff that we're missing when we have full coverage multibeam data when we just look at that chart.

I feel like it's a sin to -- what's the word? Generalize, I guess. To take all that wonderful, high resolution data and generalize it into a few contours and selected soundings. I sometimes say the word degrade, but I shouldn't. I shouldn't.

And so as we thought about the Chart of the Future, we just started to think, kind of component by component, what are the things that people might really want to see.

And I think we heard some of that on Tuesday, and I think I was thrilled to see that the idea of seeing currents and waves displayed, and again, Colin and his team are working on this is a much older visualization. It doesn't use some of the latest components.

But having the ability as you're navigating to see what the current field looks like, both now and maybe ahead of the time could be very, very helpful I think. I'm waiting for you.

MR. ARMSTRONG: Yes, and in this particular case, you know, you could see the tide flowing in and out of Portsmouth, and it's potentially a tool for oil spill response personnel to kind of see, well, if I spill something here, where is it going to go?

DR. MAYER: And here, we're seeing now in terms of significant wave height, again, the development in our lab of a new tool set, and this is a prototype now for a new nowCOAST display that will start incorporating that into significant wave height displays too in nowCOAST. That's not quite on the books yet, but it's in the works. It's soon to come out.

One thing, we have tide predictions; we have tide data. Why can't the chart be tide aware? And in this case, again, Portsmouth Harbor running the tide model. You're seeing for a given underkeel clearance a go/no-go caution thing, zone.

You can do that in real time or maybe even more importantly as a planning tool that you can sit ahead and plan your route up and see, I better not be there at that time, and get feedback into the planning process.

MR. ARMSTRONG: And I would point out that Rick and his team did something similar, because Rick was involved in that one as well when he was a grad student.

DR. MAYER: I should say, Rick is one of our proud graduates. I'm proud of him. I don't know if he's proud of being a graduate.

MR. ARMSTRONG: And so that concept was used in the Long Beach pilot as well.

DR. MAYER: And something else we've

been doing again, trying to take advantage of state of the art technology is using handheld devices, the concept of augmented reality, being able to look out at a georeferenced, holding a georeferenced device, seeing a buoy, being able to identify it, but also maybe noting a buoy's out of place or things like that.

These are things that are just kind of stewing along. And here is this small, inexpensive, virtual augmented reality simulator. And this is a tool for us to develop stuff to, but I could also see, for $1,000 -- not $100,000, $1,000 -- you can have this in the back of a bridge and just practice running up a harbor or something that you're going into, not a $60 million simulator.

And so all it is is basically a laptop, and the screen isn't even necessary. That helps us operate. It as a laptop and this set of goggles. And this is, when -- we just got a new research vessel, 48-foot research vessel, had it laser scanned, and so this is an actual picture of our bridge. This is coming into New Castle in -- that's all real imagery in the background.

We can change sea state; we can change conditions. But superimposed on that -- that's the virtual reality aspect. Superimposed on that is the augmented reality, so all the buoys, things like that. And we're just starting to develop those kinds of things.

And again, maybe from a training perspective, I'm not sure you want to navigate this way. I wouldn't. Even I would say I wouldn't want to navigate this way. But certainly from a training perspective, a very, very simple, easy and inexpensive approach.

And it has lots of amazing flexibility in terms of -- and that's all -- I mean, there's no cartoons there. That's all real data there, real imagery of the coastline. And it's 57 objects I think.

Okay, and finally -- what?

VICE CHAIR MILLER: Do people get

seasick using that?

DR. MAYER: Yes, they can, yes. So finally, and this is the challenge I put out: what will the Chart of the Future look like? And again, it doesn't have to be one thing. It's totally adaptable for the situation, for what you need.

It can be a standard display. It can show the high resolution bathymetry. In this case we have panoramas. It took us about, oh, less than a day for Portsmouth Harbor to get a complete 360 degree video panorama of the harbor.

Color-coded, whatever you want, just the chart in there, the tide aware business. The key is to have flexibility, a regular old chart, linked windows, whatever you think is most suitable for the need.

Or if you have a need to really -- and you think it would really help the situation to see the full 3-D situation, see the context of your hull and your vessel. And I should again say there's no cartoons in here.

This is all real data or real bathymetric data, and the real data around the harbor. This is showing how these panoramas are made. But it's not that difficult a thing to put together to be able to see the vessel in the full context.

And again, maybe not as a tool for navigating a big vessel or a small vessel, but certainly as an aid to that navigation and understand your environment and the situational awareness and for many, many other applications.

This could be for my world in geophysics, for habitat mapping and things like this, this may very well be the primary mode of display.

So let me stop there. And I don't know what you want to do in terms of go on or open for discussion.

MEMBER GEE: I think we've got, as I said, we would like to I think have -- I have a very short memory span. So unfortunately if we leave the questions until later, I'll forget. And

I can't read my writing.

So I think -- I'm sure people have some questions for Larry, or comments?

DR. MAYER: Or Andy.

MEMBER GEE: Or Andy. And Andy as well. Yes, Ed?

MEMBER KELLY: Larry, what would the scalability of this be because, you know, I'm looking at dichotomy. We can't get accurate surveys for the Intercoastal Waterway. And now you're looking at this high definition, which is also subject to, I presume, daily change.

So what's the practicality of the scalability? How could this be used on a large scale for a full coastal range, and how does it get updated? And is this something that can exist in a lab, or is it something that can be funded and actually implemented?

DR. MAYER: Yes, so the scalability is really just tied into the availability of high resolution data. I mean, we could do this with low resolution data, and in all honesty, I would not want to do it.

I think you would see a depiction of the sea floor that would just, it would leave you cold, and it's not accurate enough.

MEMBER GEE: And that's why people say that it's no use for navigation. I think the comment we heard the other day, that's exactly why.

DR. MAYER: But where we have, and there's tremendous efforts now obviously to start collecting 100 percent coverage, multibeam data for more and more areas. And it's a simple thing. I mean, I could put any bathymetry in there at whatever resolution exists.

But it's certainly not a difficult task once the data exists -- to come back to Joyce's comments --- once the data exists to put it in. So in that sense, and the other sets of data, and what we hear from Carol about LIDAR data, LIDAR data's a very appropriate scale for this kind of visualization. And that, for a lot of the coastal areas, is collected very, very quickly.

So I think we have a -- there's probably a beyond LIDAR range, shallower than 30 meters or so. There's a zone. I'm going to call LIDAR range on the East Coast, you know, 10 to 15 meters. We'll hear from Carol.

MEMBER LOCKHART: Yes, I mean, basically 10 to 15 I would say is good for LIDAR and anything --

DR. MAYER: Yes, and so there will be a zone where it's going to take time, but it's happening. It's coming along. It's really very impressive the efforts that are around by NOAA and by even local organizations.

And so it comes back again, how do we find all those data sets? I mean, the State of New Jersey after Sandy has done an amazing amount of this kind of mapping.

MR. ARMSTRONG: And incorporating Corps of Engineers data in the channels. We heard the problem of channel depiction. And so, in many places, the Corps does have full resolution multibeam.

DR. MAYER: Kim?

MEMBER HALL: Kind of a different type of question. As you are able to get more fidelity by adding more and more data sets to provide a kind of overall picture, what is your responsibility to protect that information. Because once it becomes information somebody can use, there's misuse and illicit activities.

You know, if you tell me where all the tuna are and I'm a poacher, now I've got this picture of the school running around that I'm just going to go take my net and put it there.

So where's the responsibility for that because as you get more and more -- I mean, I know the Navy would just slap Secret/NOFORN on it, and you guys can't really do that.

DR. MAYER: Yes, I think if you want to address that. I'll let Andy answer first, and then I'll offer.

MR. ARMSTRONG: Yes, and Rick is probably actually the best person to answer this.

But whenever NOAA does high resolution hydrographic surveys now, we have to consult with the State Historic Preservation Officer.

So there's historic wrecks that are potentially subject to looting if it's released. So all our surveys go through a screen by the Historic Preservation Officers. We sometimes work in sanctuaries, and we consult with the sanctuary managers on that.

So that's a good point, and I don't think all the ramifications are completely worked out, but certainly NOAA is sensitive of that and working on that issue.

DR. MAYER: Yes, so that's from the National Security perspective. And I agree totally with Andy: we follow whatever guidance and constraints that are imposed.

You mentioned another part, the fisheries aspect. And when we first started doing multibeam mapping of fish schools, I would give a talk about it, and people would say you're going to find every fish in the sea. You're going to lead to the destruction of every fish in the sea.

And maybe it was a cavalier answer, but my response was our job as scientists is to find the truth. And that information is just as important to the managers, too.

And so we provide that information to the managers, and then they, it's their job to set the appropriate fishing regulation. But it's important.

The issue with the first multibeam mapping of fish schools was that the standard at the time was to use a single beam echosound, or the EK60s, down the middle, and it would just go down the middle of the ship.

And the fishermen contended that the fish schools would part. They were avoiding the vessel and so that the hydroacoustic estimates of fish abundance were tremendously underestimating. And so they were being restricted on counts that were way too low.

And it turned out when we saw the

multibeam data, that was actually true. The fish schools were avoiding the vessel, and so they got a very, very low count. And the fisheries people increased the total allowable catch because of that, and that's why I got yelled at.

But I said but that was the truth in that case. And so I'm just pushing off the responsibility, saying it's the manager's responsibility then to use the true data to find what the total allowable catch is.

MEMBER HALL: I guess just when I see some of those pictures, it seems like you could accidentally include something. And if I'm a smart, nefarious actor I'm going to go see that because you're providing so much data in one picture.

DR. MAYER: Yes --

MEMBER HALL: So how to control how that picture gets seen with still telling the truth.

DR. MAYER: This is a -- well, the truth part is a different aspect. I mean, national security is something, it's a line I would certainly never cross. And always, I think we all have to respect national security issues.

Many of these data sets start off as publicly available anyway. So they're there if we fuse them.

MEMBER HALL: Yes, it's just that the government is always really good once you start putting data sets together and it becomes information, not just data. That's when we stamp a nobody else can see it status on it.

MEMBER SAADE: Can I jump in? So along those lines, for instance, we did survey work exactly like this off the State of California for the State of California. And the whole goal of that was to release it to everybody.

That included finding obvious restricted areas for fishing so they could close off areas to make sure fishermen didn't fish there because it was so obvious that it was a nurturing ground.

But it also meant that the surfing interests, for instance, could take the multibeam data and finally on their own determine why Mavericks breaks at 30 to 40 feet, because they did their own analysis of what the hydrodynamics were of the wave front coming in because we mapped this perfect little launch ramp that made these giant waves.

That went viral. And from the State of California's point of view, that was the greatest thing ever. Everybody's using it for their own reasons. It's not just the mariner, it's not just the fisherman.

And I say you should make a comment about commercial fishing sonars which are essentially multibeams that every single fishing boat has anyway.

DR. MAYER: That's true. Yes, I mean, at least in Canada, the biggest owner of multibeams in Canada are the fishing community.

MEMBER GEE: Lawson, sorry.

MEMBER BRIGHAM: Yes, I mean, Larry's

right on. The coast pilot today, the hard copy doesn't have a lot of utility for the modern integrated marine management of an area.

So in Alaska we're looking at an electronic version of a coast pilot that has all this bathymetric information, particularly of the roots that are being developed, the voluntary rooting.

But the most important part of this coast pilot would be real time indigenous use on the ice or in the open water or whatever so that the master of the ship would have all of this information real time as a ship comes up.

And it would be the modern electronic coast pilot. But important part of it would be, in fact, this 3-D, 4D information imbedded. Not six months, real time. It has to be real time because the ship is navigating.

This is all a new tool for enhancing marine safety and environmental protection in the arctic.

MEMBER GEE: Thanks, Lawson. Yes,

Susan?

MEMBER SHINGLEDECKER: From the recreational perspective, I think it's really exciting to see. I'm really curious to see what we could do with it from an education perspective to educate that boater because you really can get a sense of things maybe without even being on a boat in a much more realistic picture from behind a computer screen.

I was really happy to hear about the human factors element of it and was curious, have they been looking at kind of how much someone relies on the digital tool versus heads up in the real world?

What we're seeing is a big increase in boating accidents related to distracted boating. And our biggest press release last year was Pokemon Go. And if you're going to do Pokemon Go on your boat, you need to have another person keeping watch.

And failure to keep proper lookout, one of the most violated nav rules out there. So

I would love to know more about that.

DR. MAYER: Yes, so I know of one study that Colin has been doing that has been looking, has been tracking because they can do eye tracking stuff too. How many times people are looking out the window versus looking at, in this case I think it was a radar display or something. But that can be carried a lot, lot further.

So I think you're absolutely right, that's going to become, it's a scary thing for me. I was worried about building stuff so nice, people don't look out the window anymore.

MEMBER SHINGLEDECKER: I would love to follow up with you on it. We're doing a study on distracted boating, so it might be --

(Simultaneous speaking)

DR. MAYER: Great. Okay, that would be really exciting.

MEMBER GEE: Yes, Joyce?

VICE CHAIR MILLER: Two comments. When I was surveying in a 25 foot launch, the experienced boat drivers, the coxswains that had been on the ships forever, and we had a 3-D, not a 3-D display but a display that you could follow to map, it would drive them crazy.

And you would bring some 21 year old who never steered a boat before, and they could drive it perfectly because it's just a different skill set.

DR. MAYER: There are definitely generational issues.

VICE CHAIR MILLER: Yes. But this takes us way back when we first had the first multibeam outside of the classified community was on the NOAA ship Surveyor. And it went on in 1980.

And NAVOCEANO who was the expert in the mapping said oh, that little system, we don't need to worry about it. It won't get very good data. And four years later, and we had already published the Juan de Fuca data and things like that, four years later the Navy comes knocking and says all that data needs to be classified, after the fact.

And there was quite a battle for a while of whether that data would get classified or not. So it was just a little historic perspective on, you know, on data availability.

MEMBER GEE: Can I just comment a couple of things I guess bring it to the technology and what a number of you have said. I think the human/computer interaction and the intuitiveness of what we saw Larry provide is kind of part, that is part of it.

What it relies on is the data underneath. And we tend to focus on the bathymetry, but there was all that other data that's coming in. I think that's a difference that's coming because of the technology for NOAA.

And we think of the chart before and the coast pilot was compiled by NOAA> I think the future of what Larry is showing, whether it's lights, whether it's the shore, all those other currents and things that are around, that isn't necessarily going to be done by NOAA because the technology is there to bring that in.

But it relies on that authoritative data, I think we're saying about being able to know that that is a reasonable data set that you're using. But the technology moving forward has got to be about the data and the databases.

I don't know how you access that to better provide products for the different users, whether that be Ed in a port or Sal on a cruise ship or Susan with -- that's I think what we've, the future we're going to from the chart really.

We talk about the paper chart going, but we're talking about 200 plus year old technology moving finally to something where we have the opportunity to not just have an electronic chart, but that information system.

It's kind of the D part of ECDIS is, that's really changing. So yes, and Sam up the back just wants to say something.

MR. DEBOW: Hi. Sam Debow. This is a follow up to Ed's question. And then I have to have question from my close colleagues. Rick, when did you get your master's degree?

CAPT. BRENNAN: 2005.

MR. DEBOW: Twelve years ago. So we've been seeing this Chart of the Future for 12, 15 years. And my question is it's only in your lab. When are we going to operationalize it? When are we going to put it on a NOAA ship? When are we going to get it out there for people to use?

The maritime universities, they still teach navigation the same old way, 200 year old method. Paper charts, visual sightings, and plotting fixes. When are we going to get to the next level, operationally?

PARTICIPANT: Rick?

CAPT. BRENNAN: I thought we were going to have Christian Hempstead here. Maybe, is he, was he coming?

(Off microphone comments)

CAPT. BRENNAN: Well, so this is the question that we've been asking Christian every time I would go back to a refresher training and he would provide an ECDIS training course on that.

And so really, you know, I feel like at least on our NOAA ships we've been dealing with this head-on with our ensigns because we get a whole cadre of new ensigns and we're training those guys.

And we have all of this technology, so we're making our own charts and we're making the charts that Larry is showing, so we take our DTMs and we put soundings on them. And so we'll go survey an area before we take the ship in and make our own chart, and then go in and sail on it.

So we know exactly what we want on our charts. And we make the charts to look exactly the way we want them. And so we get the best of everything when it comes to that.

And then we also have to deal with that human/computer interface issue of how do I keep that ensign from looking at the computer that's on the aft wall of the ship when we're steaming 12 knots in the other direction and making sure that, you know, okay well that's great that that's where it's at but the window is that way, friend, and that's the way you need to look.

So we deal with that quite a bit. The one thing I would like to point out that I think is exciting is that when you go back to when we did S57, you know, 30 years ago now or maybe longer is that that was a top down driven standards process, right?

And so that was designed and created and worked on at a very high level and then pushed out to the industry into the field, into basically all of the users.

The thing that I think is really exciting now, and where we're trying to take this, and that's what the whole Long Beach process was about, was the fact that with these portable pilot units that are out there now, they're unconstrained by IHO guidelines.

And so we can really start pushing

different data techniques and different products through that portable pilot unit, test them out in kind of nice, concise little real world laboratories and see what works and what doesn't.

And you know, and the analogy that I've been using is giving the mariner that eye test. You know, does this one look better, or does this one look better and try, and reiterate very fast and kind of grow that from the ground up.

So both between the PPUs and the ECS systems, test that there and then push it to the IHO and say we think that this has been tested, we think that this is the best format and the best available, you know, the best way to display this, and then make it an international standard.

And it's a different approach. It's a grassroots up instead of a top down. And so I think to sort of answer Sam's question on that, I think that's where we're trying to push that technology up and into the industry in a completely different direction. And I think that's going to be very powerful.

DR. MAYER: Rick is absolutely correct about that. When we started the Chart of the Future project, we had two streams. We had what we called the evolutionary stream which was going to try to work within the standards and see how far we can go which was not very far.

And then all the stuff you've seen here, most of what you've seen here has been on the revolutionary track instead of evolutionary which basically said we're unconstrained by IHO standards. Just let's kind of play around and see what we would like to see.

But now as Rick's saying, the two are starting to come. And so Briana is going to a lot of strange meetings with TIGWG and IGWG and the Current Working Group and this working group trying to get a number of those types of displays accepted now in the standard process. I think Rick's absolutely right there.

MEMBER SAADE: So we need to move on. I get to have the last word. So in answer to

Sam's question then I have a really easy solution. Let's get the data out there.

We have all this data collected in Alaska and everywhere else that NOAA and the contractors are collecting is just sitting on a computer somewhere.

If the users on all these vessels had a chance to look at this tremendous amount of information of imagery and other types of things on the sea bed rather than just soundings and lines, and they started to get used to it, and they started to like it, that puts a demand on everybody that's involved in this.

Or, and I'm aware of this because I know some people in the industry, folks that on cruise ships, if cruise ships are going along and part of the display in the ship was this, a long track line of the sea bed so you can see all these interesting features that no one knows about, that's another way to get the word out there and get the public and the end users to get excited about this stuff.

But until we do that, we're kind of stuck in the rut of it always being in the labs and not finding a way out to the public.

DR. MAYER: So the group that took this on most quickly was the Navy submarine fleet because they have to live in a truly 3-dimensional, 4-dimensional world. And so they were very quick adapter, but they also I think can relieve some levels of chart regulation when they need to.

MEMBER GEE: Okay, yes. Thanks, Larry, that was, you got the discussion going. And we want to now move on to the next presentation. We will I think at the end of this and then after the break, we'll have a brief summary of what we did during the technology working group.

But I think if we want to continue the discussion sort of before lunch, we hopefully will have time.

Now moving back to the ports, but more in a broader port sense, not just bathymetry that we often talk about. Marten from Esri is here to present for us.

And we've heard about the Port of Rotterdam and where I think people talk about it from different levels and have different views of it. And so we thought it was worthwhile from, and is the program manager for the implementation of GIS at Rotterdam to present to us that activity. Thanks, Marten.

MR. HOGEWEG: Thanks, Lindsay. So thank you very much for the opportunity to talk here a little bit about the work that we do with ports. I've been working with the Port of Rotterdam specifically for the last four years or so, focusing really on using data as indeed a fifth modality for them.

Before that I worked at, with sort of USCS Department of Interior on the national data sort of problems, geospatial one-stop during the Bush administration and geospatial platform data.gov.

Kind of the theme among all of this is

that data can help drive decisions can help make things go smoother, better, faster, and hopefully cheaper from a port business perspective.

So a port obviously uses a lot of different modalities, right? The Port of Rotterdam is one of the largest ports in the world. It has, for the longest time has been the largest port in Europe with about 3,000 ship movements a day, 2,000 to train cars sort of moving throughout the port, thousands of trucks going in and out.

And the port is a big port. It's about 40 kilometers wide, west to east, and it's built into the urban infrastructure of the City of Rotterdam and a few other cities along that waterway.

So it has a few very specific challenges. And one of the things that the port realizes is that physically they cannot grow anymore. But they set an ambitious goal of doubling their throughput over the next 15 years. And that means they have to be smarter, right?

So they will not be the biggest port in the world, those can be found in Asia, of course. So they set their goal to be the smartest port and to essentially one of the things for example they said is to not leave a centimeter of cargo space unused. Right, that's one way you can grow.

So think about under keel clearance there. So between cargo and other materials sort of entering and exiting the port, it actually goes through quite a few hands, right?

People who have a particular role in handling the ships, pilots, harbor master control, shoreline staff, but also people who work on say the sale side of a port, right, port development, trying to acquire new customers, trying to do strategic planning for the port for this 15 year period.

They all have their own asset managers, they all have their own very specific views of what a port actually is. Not very different from what a local government would do.

If you are city planning, if you are a law enforcement, if you are housing, et cetera, you all have your own different views of the objects, the assets in the port.

And so that is what the Port of Rotterdam really sort of made to focus on a data strategy. The goals that they try to sort of achieve with that is to increase things like efficiency, make decisions faster, using common data.

Sort of everyone has the same kind of view of what the port is, how wide is a berth, how deep is a berth, and these sometimes sound like trivial things but they're honestly not very trivial in any cases.

Communicate more effectively with both internally with other departments, between departments. In many cases we see with organizations not limited to ports is that different departments don't necessarily communicate, maintain their own data sets, et cetera.

Attract and retain business, of course the port business is a highly competitive business. Think about western Europe between Antwerp, Rotterdam, Amsterdam, Hamburg, a lot of different ports are trying to attract customers. And so you have to distinguish yourselves from those.

Improve awareness across the enterprise, what's happening, what's going on, et cetera. And then better managing, utilize the assets. So asset management was one of the drivers of this activity that we had with the Port of Rotterdam.

They spent a lot of money on making sure that quay walls are operational. If quay wall is not operational, that is an immediate loss of revenue for a port. So plan your maintenance activities, plan your construction activities with minimal impact on other things that happen in the port.

So that led them to essentially establish a number of what you might call systems of record, the core systems. That's where you go to get kind of the truth of the information that the port handles.

And they established a GIS as one of those systems of record. Between their enterprise systems where they manage asset and contract information, and document management system as well as CAD systems, right, engineering drawings are typically done in CAD systems. So GIS became really an enterprise system just like email or an internal portal might be an enterprise system.

What they also did is create what you might call a location strategy. And when we talk about a location strategy, we distinguish these six individual patterns, if you will.

One is to enable an entire organization with the information. In the past, Port of Rotterdam as an example, that was the guy who was the GIS guy or the map guy, and he was basically busy the entire day making maps for everyone else in the port.

That was flipped around and everyone in the port can now make their own maps. So about 1,000 people working at the Port of Rotterdam look at maps, make their own maps using the same data as everyone else is using.

All right, so this is kind of a ubiquitous mapping within an organization, and outside of an organization.

Constituent engagement, there's a lot of external players in a port, trucking, truckers, shipping agents, and visitors, right? I mentioned it's an urban area so there's villages and other transportation networks in the area.

Support decisions, enable field staff, inspections that are done in the field. Everyone has to understand the same objects in the same information.

There's a lot of analysis that's happening, right? So some of the visualizations that we saw just before, some of those are in some ways being done at a port as well to analyze for example underground objects.

The Port of Rotterdam is deepening some of the waterways over a stretch of 20 kilometers, deepening it maybe with a few meters. There's tunnels, there's cables, there's pipelines that go underground. There's structures on either sides of the waterway that you have to account for.

So they need to have these advanced visualization and analysis capabilities.

And last but not least, manage the data. Right? So yesterday we heard a couple of sort of comments about data being old, bathymetry changes, sort of the waterways change very frequently and you've got to keep those things up to date.

So we spend a lot of time automating a lot of the processes around data management.

So the Port of Rotterdam activity really was a kind of an organization wide activity, from asset management to the harbor master group that was part of this. We apply a geo design concept which is really looking at designing a port.

A picture in the middle of this particular slide shows a master plan, shows the current situation where you see on the left side is the new area that was recently claimed, or reclaimed from the North Sea. This is about as far west as the Port of Rotterdam can go.

There's empty space there, there's a lot of water there. In the future there will be new terminals and quay walls and et cetera designed there.

So do you make those container terminals, do you make those refineries, do you do liquid bulk or dry bulk? Where do you put those things? And so the port is using spatial analysis to help inform those decisions over the next 25 years.

So internally, the staff within the port has access to maps. I mentioned this, right? So everyone in the port can do their mapping within different departments of the port.

Specific thematic maps have been created and made available. All of those are based on the same underlying enterprise databases.

All right, so here's an example. And this may also seem kind of a trivial example, but we see many ports having challenges with even putting something like this on a map.

So when are the leases, when do they expire, who's the lease holder, can we see the contract documents for those. All right, so really connecting all these different systems of documents, engineering drawings, and spatial data together in one view.

And this view might be configured for someone who is in the sales department of the port or the contracting department of the port. A different department may see the same objects but totally different view because they have a different need than these.

What you see here is more specific to the asset managers. So they look at a key wall in different views, right? So top is a planar view, the typical map display. The dots that you see off the right in the blue areas are actually locations of panoramic photos.

So 360 degree photos have been taken all along the port. They do this on a yearly basis. This allows an asset manager to take a view of a quay wall and defenders and the boulders that are on the quay wall without actually having to go there. They can inspect and visually see what the situation is.

Below that photo you see an elevation view of the same quay wall. And you see objects that are under water, the anodes that protect the steel construction of the wall. You see the fenders there and so on.

So this is a kind of a view that allows you to see objects that are not directly visible. If they do inspections of those anodes, a diver goes in, they take the anode out, they weigh the anodes. And then from there it goes into a system that then predicts the degradation curve of the quay wall that helps asset managers plan their maintenance activities.

Very different view of the port. Of course, navigation is a key aspect in the Port of Rotterdam. So you see the bathymetry here. The Port of Rotterdam actually operates their own survey vessels and dredging operations. They manage all that.

The port is a river port, so there's a lot of sedimentation coming down. Plus, one of the key distinguishing elements of the port is that they are a deep water port. So the areas on the left are one of the deepest port areas in the world.

What you see on the western side is this triangle, or I'm sorry, this rectangle that is sort of a very deep area. So even though this part of the port is not fully developed yet, the port has figured out a way that water is actually an asset to them.

So they leased out this particular area to allow the finalizing of the construction of the Pioneering Spirit, the largest construction ship in the world. And they had to dredge this particular area especially deep because otherwise the ship wouldn't be able to actually get into that particular location.

So that is the kind of thinking that the port is doing. Right, so they see they have water, it is an asset to them, it can generate, help them generate revenue. How do we do this, and one of the ways is to use the dredging.

This dredging is done on a very frequent basis. You see the individual basins, the red parts are shallower. Obviously there's, when ships arrive there's a guaranteed sort of nautical depth. There's a maintenance depth that the port needs to maintain.

So one of the things we have done is to use the AIS data feeds to get under keel clearance data and to then sort of compare that with the guaranteed depth in those areas.

So using that mechanism, we can automate the process of deciding where to dredge.

And the port is trying to sort of implement this mechanism of just in time dredging.

Right, you want to dredge right before the ship arrives. You don't want to hold up a ship because if you're dredging, plus if you dredge a month ahead of time, then it doesn't really help when the ship actually gets there.

All right, so data driven planning of dredging operations, replacing literally paper dredging with sticky notes, where did we dredge last week, where do we go next, and so on.

The same data is being used in the navigational charts. So the Port of Rotterdam generates these themselves. As I mentioned, they have their own survey operations. Those surveys, they come in on a daily basis, frequently.

And we automated the process of updating the bathymetry and the navigational charts, so the port has updates of these navigational charts a number of times a day, really going from maybe once a year or so in the past.

So that is sort of really helping them sort of improve their ability to give the visiting ships up to date information.

These same charts use the same technology as you might see in the NOAA ENC online application. And we're using this information also now to start working with the port.

Actually, it was interesting to see some of the visualizations about route planning. So we're working with the port now to help shipping agents plan their visits to the port. So safe passage, safe berthing.

And along the route from sort of point of entry to an individual berthing location, there might be different maritime conditions and restrictions that apply based on the tide, based on the weather conditions, et cetera.

And so we're trying to automate this tying it into real time hydro and meteorological measurements and sensor networks. And so this will be something that we're working on next.

So in addition to this data foundation that we created over the last couple of years, we're now moving into actually utilizing the data foundation to support very specific processes within the port.

All right, so very different approach is seen in the Port of Long Beach where we have worked with their port security program, bringing together local, state, and national, federal law enforcement and disaster response agencies.

You see a couple of sort of examples here of what you might call an event management system. So if a ship with hazardous goods arrives in the port, we need to be alerted.

If the City of LA decides to, or Long Beach decides to organize a marathon, we need to be alerted. If there is suspicious activity because we're close to the border in the Long Beach area, suspicious activity happening, we need to be managing that, and sharing information with all these different agencies.

All right, so ports are not just about

the work they do themselves. They also need to connect with other agencies in the area or even beyond.

In the case of the Port of Long Beach, the system that we built there, again, replaced a paper system. So in this case there was a daily brief that was held, someone wrote a little report, sticky notes on the wall indicate what's happening where and so on with the system that was put in place there, working jointly with many different data providers and different agencies.

All of that can now be done sort of electronically, can be done in the field from a mobile device, can be done from the individual agency offices, et cetera, all in a highly sort of protected and secure environment.

So here's sort of a brief example. So events happen, ships arrive. Obviously those are the ship locations on the left hand side. We can schedule events and see what's going on in the port.

So all of this kind of comes to this

conclusion that information really is, has to be seen as a modality, right, as a core aspect of what a port does and how a port operates, and honestly is not just limited to ports. This applies to cities if you think about smart city initiatives around the world or government in general.

So you might think okay, we got a handle on it, right? But we all live now in the age of our fridges telling us that we need to buy milk and the washing machines telling us we need to add more soap.

Sort of personal story. We got a new washing machine, and apparently if the thing breaks, I can hold my phone to it and it will tell me what's wrong and I can send it to the manufacturer and it will ship me a part or something. Something will happen.

So big data, right? There's various flavors of big data going around. NOAA as an organization is highly involved in big data initiatives.

One of the things is volume. Right? Some of the simulations we saw this morning, those are, and actually the discussion yesterday about the prediction models, those are becoming very, very large volumes of data.

You do not download those data. The gentleman next to me made a comment about this. The data is available, but beware, right? So you have to think about the different solutions.

The typical approach with big data, voluminous data is to actually leave the data where it is and bring the analysis, bring the use of this data to this data. Right, so total shift in a paradigm there.

So a website with, or an ftp site with files to download, that's not going to work in this new age anymore. You see this already with various sort of satellite sources.

Think LandSat with USGS or think the GOES 16 satellite that was launched recently. That's going to make a lot of data available and accessible. And how do you bring that data to the end users.

The other aspect, or one of the other aspects of big data is speed, velocity. So ships don't move very fast. In a different context, think about cars, right? Connected cars are coming, autonomous cars are coming. They do move very fast and close to each other.

Very unpredictable, at least as long as people actually drive them. And so you need to be able to handle large volumes of data as much as you need to be able to, or frequency of data, frequency of updates as much as very much volumes.

So one of the things we did with the Port of Rotterdam, you see a small picture there in the lower right hand corner is we actually store all of the AIS data. And they've built an archive of maybe eight years by now, 15 minute interval data of about 1,000 ships a day.

And you can kind of imagine the volume of that. Out of this large bucket of data, individual users, end users who do not understand big data technologies, who do not understand GIS per se even, they can extract information, they can get the information they need.

It might be ship density. What is the busy area in the port on a Friday afternoon or Monday morning or during the weekday or so on. And can we somehow mitigate this bottleneck.

Or in this case, count ships, right? Ships, they draw a line somewhere in the port, they count ships going in and out. And they use this for capacity planning purposes.

They also use this in the case of calamities. If there's a collision of some sort, they can retrieve the track of the two ships, or of the one ship if it runs aground somewhere, and then replay and visit, combine this with those 360 degree views, they can get a fairly decent picture of what's happening in the port.

Finally, in terms of big data, variety. This may apply very much as kind of the social sciences. Think the Census Bureau where you collect many different types of information.

And in a port, this happens as well. But outside of the port obviously there's other situations where this comes.

So you've got to be able to handle all of these data, right? When something happens, when there's a storm, weather affects shipping traffic greatly.

Whether it's a storm or whether it's another situation, how do you deal with this large data amount. So that is part of building this strategy. You got to think about it ahead of time, prepare your infrastructure.

The technology is here. So there was a question about can we move this into operation. Yes, you can. Technology exists. It takes some planning, it takes some assembly. But you can then create your environment that actually captures the value of being a data driven organization.

All right, so there's new opportunities that you might uncover. There's ways, location is an interesting thing. You don't really create all these relations of things. The fact that there is a name card on the table, there's no database where I can look this up but the name card and the table are close to each other in order the people in the room are in the same room and so on.

So location allows you to discover relationships that were not obvious and patterns that were not obvious. Make decisions faster because the data is ready to go. Make decisions better because you can evaluate alternatives, you can understand uncertainty in data and so on, you can be better informed.

And make decisions ahead of time. Right, so reducing, so weather prediction, right, so being able to forecast the development of hurricane, maybe an hour or two hours ahead of time actually will save a lot of life and assets.

You can also improve your efficiency. So as an operation, this would be of course critical to a port. In the case of Port of Rotterdam where they say well this is really the fine tuning that we can do over the next 15, 20 years to be able to achieve that goal of doubling throughput. Reducing costs, improving processes, et cetera.

Now this, in the case of a port, so I spoke a lot about Port of Rotterdam, a little bit about Long Beach, a port is not just limited to sort of the water and the terminals and so on.

If you look at these pictures here, those are transportation networks and congestion that happens in those transportation networks surrounding, for example, the Port of Seattle.

One the way here from the airport, right, it's 2 o'clock in the afternoon and the road is blocked and it's fixed, right? It's stand still. So as a port you have to look at the surrounding and sort of the hinterland.

So where does your cargo go? Case of Los Angeles Port, you can see where the goods are actually going. In the case of Rotterdam, the goods might actually end up in Poland or in Czech or in Hungary, far away from where the goods actually arrive.

And how does it get there? So European Union and is looking at these trends, European Transportation Networks, and really planning it not just from a single port perspective, but now from a network of ports and a network of sort of a logistics network if you will, a supply chain at work.

So these are some of the thoughts maybe I had about using data as a modality. I think there's a lot of opportunity to use this, take this approach with the United States ports.

We've worked with a number of those. There's opportunities to kind of use data that becomes available from federal agencies such as NOAA, and also contribute back, right?

So one of those topics of crowdsourcing navigational charts or bathymetry data, I think there's a close relationship that can be built there. Thank you very much.

MEMBER GEE: Thank you, Mark. Yes, I think the comment at the start, I think we see now as the data and the infrastructure support that is really part of the infrastructure report, and it's not just the hard physical keys and ports.

The other thing is I think we're just talking about technology here and it was just to kind of bring that in to see, to give those that haven't been exposed to it what was happening and what, in this case, Esri is doing with the Port of Rotterdam.

But I think on top of that was interesting as some of the drivers in that slide, I really liked that slide about the drivers of what those were, of how an organization would convert.

And that I see is a whole other issue that's outside what we do is the drivers to ports in the US and how does that relate and how does that change because the business that there is the technology there I believe to do this as we're seeing. But to understand what the business drivers are to accept that technology, that's a whole other issue outside what we do, obviously. Yes, so comments. Larry?

DR. MAYER: A question. The very high resolution bathymetry that you showed that you think is updated almost on a daily basis, is that provided to the vessels too, or is that just for the internal workings of the port?

MR. HOGEWEG: No, that is provided to the vessels as well.

DR. MAYER: And how is it provided to the vessels?

MR. HOGEWEG: They use, and so we provide the data basically to the provider of that device.

(Off microphone comments)

MEMBER GEE: And it's also provided to the pilots as well through the portable pilot. It's part of an integrated system if they have the pilots actually are integrated into that. And I think when they're going on a ship they log in daily.

And also --

DR. MAYER: I can see it for the pilots. I'm just wondering about the vessels itself because if you're supplying it through the ECDIS, there has to be an interface through the ECDIS manufacturer. And how you do that on a daily basis is something I think, Sally, you were talking about last night.

If there's some way to get the data directly to the vessel without having to go through the ECDIS manufacturer, if there was a standard format for distribution of that data.

MEMBER RASSELLO: Yes. Rotterdam updated the charts with the IHO. This is the same process you should use?

MR. HOGEWEG: Well, I mean, sort of the data in the end that both the bathymetry and the ENCs, they are available in the IHO standard format. And those are then distributed to various places.

MEMBER GEE: But it's interesting. I think the port took the, I think there's an agreement between the Netherlands Hydrographic

Service and the Port of Rotterdam for Rotterdam to take the responsibility for basically doing kind of distributed --

CAPT. BRENNAN: It's a completely different system, right?

MEMBER GEE: Oh, it is.

CAPT. BRENNAN: It's a completely different country, and they deal with it, and I mean, so the ports there, they have the charting responsibility. And so they are the ones that deliver the chart to the mariner before they get in.

And I'm not exactly sure what that method is, if it's broadband or they, you know, do it via satellite connection or the pilots carry it out to them. But yes, they're updating it and they control the entire thing.

And so they have responsibility for the surveying, for the mapping, for the dredging. They control all elements of it. So it's a very desirable state to live in in that regard.

MEMBER GEE: Yes, and it was a good,

I think the important thing was that there was the business decisions drove that. And that's I think, that's outside this. But the technology is there.

And so from our point of view, it was just to show that the technology is there and it's working, and then okay, everybody over to the business to see how you can improve and make things more efficient.

But I think one of the interesting things also is this real transition from, in this case, and this applies to many in this industry I think is going from a product based organizations to data driven organizations.

And that's a big change that I think has happened to us without knowing, and we keep seeing it. But it does need a shift in the paradigm of how organizations operate. And see the benefits of why they do that.

MEMBER PERKINS: Captain Brennan, how prevalent is that model internationally of the port being holistically responsible for the surveying and the charting and the distribution?

(Off microphone comments)

CAPT. BRENNAN: Certainly northern Europe, very prevalent there. I mean, that's almost the de facto model of how it's run. So I think there's a, certainly when you talk to American ports, and Ed can correct me if I'm wrong on this.

But I mean, most of the ports don't, you know, they think they don't take on the charting role and they don't even think of that as really the port responsibility in a lot of ways.

So at least in my conversations with ports, they're really thinking much more about all the shore side infrastructure and all the things that happen once the ship actually gets to them.

And to the extent that there is water involved, it's very much focused entirely on dredging. So it's not as holistic as this approach is where they're looking at the entire ecosystem.

I mean, I think we're getting there, it's an evolution. But we've had the, I think in the past we've had the benefit of having, you know, much deeper ports and we haven't had the ships pushing the limits of those ports like we're seeing today. And I think that's what's driving us in that direction now is that the ships are starting to tickle the sea floor a lot more than they used to.

MEMBER KELLY: Yes, Rick, I would agree. The ports themselves are typically concentrate on strictly dredging responsibilities for the berths themselves and the connector zone to and from the channel.

But other than that, they'll issue controlling department and not really about charting, but that they have the responsibility for dredging that private area.

MEMBER GEE: I think that comes again to thinking how they manage the ports. And one of the, I guess my recent experience with the Panel here and looking at the issues we've talked about with construction and how these tie together and with the dredging project or a construction project in a port, and it seems to be in its little silo, and then the charting is in another silo, you know, part of the project is getting a chart, getting the chart out.

To me, I think we're drawing a boundary at the end of the dredging project whereas the project's not finished until it's charted whether who's doing it, it doesn't really matter.

It's not even charted. It's the data is available in an authoritative form in a product for the person who needs to bring the ship in. I mean, you can connect that better. Maybe there's a change to discussion slightly I think. So maybe.

MEMBER GEE: Yes, we remember also it's a constant import of new data from different parties. The berths are dredged individually on different schedules, the main federal channels are dredged on different schedules.

Depths changes, so there's a constant flow. It's not like we do the whole harbor once and then go back and do the whole thing again.

MEMBER KELLY: No, but I think the technology to allow that management of that is now coming available, and then it's how does a business relate to that to improve the efficiency of that.

MEMBER GEE: It's definitely room for integration. The reality is now there's a lot of different silos.

MEMBER KELLY: Yes, yes.

MEMBER BRIGHAM: I mean, this is all about the strategic management of complexity, right? But in this case, this port is so central to the Netherland's GNP, I mean, essential huge thing, I mean, our challenge is a bit more diverse.

But in some sense, New York and probably LA, and not necessarily here have done this, but in rudimentary ways and not using 24 century technology.

But this is intermodal too. I mean, you made a point that it's all the data of the intermodal connections, the rail and the road and the whole thing. I mean, there's a little bit of that done in the United States but probably not enough.

And it's all information driven and it's all for efficiency, and it has some security elements in it, but it's complexity, right?

MR. HOGEWEG: Yes. Especially on the kind of the strategic planning side. We're looking there. If you implement a particular container terminal there or you improve the sort of the capacity of the terminal, it's going to result in more traffic movements.

Can the road network actually handle it, and if so where does the bottleneck occur, right? And can we do something on that road network to kind of mitigate this.

MEMBER GEE: Sal?

MEMBER RASSELLO: I think that this

has changed a little bit the way a chart is displayed, right? Now it's on electronic, it is not as the few lines on the paper chart. Now we have colors, we have, we can put 3-D in, we can put all the fancy thing because of the digitalization of the chart permits to do whatever we want.

So we need to establish who's going to take this on. I think NOAA is the best entity to take this on end and put forward the way the chart should be structured from the open sea, from 30 meters of depth which is the fault depth up to the pier, including what information you mentioned for the Port of Rotterdam, we want to know what is the depth by the pier to allow the ship not just to transit, also to berth.

This is aware is the point is that who's going to take this on and collect all these silos. I told this information and put down the process the problem to repair the product.

I also like what the Captain said regarding we want to push through the little pilot laptop to start this process. But I think that's going to be a very long, take long time to push into the IHO standards.

MEMBER GEE: The reason the portable pilots, you know, because they had an immediate demand to end the ECS. Those people had an immediate use and it wasn't satisfying a requirement.

(Simultaneous speaking)

MEMBER RASSELLO: -- still isn't legalized, so it's something they use on the side like we say yesterday. But it has to be on an ECDIS chart. For the use of the bigger ship from the small leisure boat, they have the same thing. They have a chart, they have ENC.

CAPT. BRENNAN: I guess if I could say one thing on that, I mean, I think with concerted effort, I think we could get the standards accelerated.

And so I mean when I was in grad school, I mean, we had a hydro conference and, you know, Larry said the grid should be the map.

And when you look at it, that's what one or two is, the grid is the map, the gridded data.

So we're there. I mean, you know, I know it seems like a long time. But when you think about how long it took S57 to get in place, it's really moving much, you know, it doesn't seem like it but it is moving faster, and I think it could go even faster if we had some dedicated focus on getting that standard in.

But right now, that really takes getting those prototypes tested, getting agreement on that's the way it needs to go, and then transferring our production systems over to a method of producing that. And right now, we don't have production systems in place to provide gridded bathymetry products out to the mariner. And that's a change that I'll, I think we're going to brief on that at some point today. But I can talk a little bit more to that later.

MEMBER GEE: Yes, thanks. And I think it's just the comment we had yesterday about the procedure navigation paper. I think this is part of the issue is because there was a number of voices that were in there and it was the thing that's missing.

We're trying to drive from the bottom but there is this kind of what's the business push for that. I think that's something to go.

We're thinking about having a break shortly, but should we open up just if there's any outside questions or comments from both here and outside now, and then we can go to a break?

VICE CHAIR MILLER: Yes, I think we'll take a break early. It's scheduled for 10:30, it's 10:15 now. And we have one more presenter and then discussion of the technology working group before 11:45. So we'll have an hour and 15 minutes for Carol's presentation.

Lynn, are there any comments from either the floor or --

PARTICIPANT: Jon Dasler will be.

VICE CHAIR MILLER: Yes, it's Jon.

MR. DASLER: Great. Jon Dasler, Dave Evans and Associates. I think this all really ties together. Precision navigation and the data presentations and what's happening at the Port of Rotterdam, I mean, I think what we see is sort of as all these disparate data sets come together, it's sort of the ransom note effect of piecemeal and patched together data.

And at an e-navigation conference a few years ago, in fact, the Canadian Hydrographic Service was talking about that, doing a hydrographic survey at a private terminal and it didn't match the prior surveys and things were a lot different, and it's just that they didn't have the position of the piers in the right position.

And so as we pursue I think precision navigation projects, and increasing that accuracy, I think we've got to look at also the standards we're using. I mean, I don't think I chose special order really meets the needs of the precision ports requires.

Surveys could be done to a higher accuracy. I think once that's out there, everybody goes well, we can use zone times because the Corps is still using a lot of staff gauge measurements and everybody needs to get on the same page if we're going to start pushing the limits of these ports like the ships are doing in these areas.

And you know, how is the shoreline and the piers being positioned relative to the soundings. And so I think moving that forward in precision navigation, those kinds of standards and getting all the agencies on the same page is going to reduce the uncertainty of that, and I think that's where we should be going.

MEMBER GEE: Any other comments back there?

VICE CHAIR MILLER: Okay, let's adjourn until 10:30. Please come back on time. And since I don't have much of a voice, I can't yell.

(Whereupon, the above-entitled matter went off the record at 10:17 a.m. and resumed at 10:34 a.m.)

VICE CHAIR MILLER: Now please take your seats, and we'll finish up the Technology Working Group Panel. Lindsay.

MEMBER GEE: So just slowly turning from, yes, from the previous meeting there have been discussions about having some brief, technology briefs, during the meetings.

And from the last meeting we requested to talk about, we've talked about bathy, bathymetric LIDAR. We know Mike Aslaksen, his group have been doing this type of bathy LIDAR.

But since we have Carol on the Panel, and she's an industry expert, we've invited her along to give us a brief on that.

MEMBER LOCKHART: Thank you. Okay, so over the past couple of years on the Panel we've had questions come up about bathy LIDAR. Often in the sense of, well, it sounds like bathy LIDAR would be a good tool for this, and sometimes the answer is, no, it's not, but we didn't really give further explanation on that.

And sometimes we're not using where we

maybe could be. And so we wanted to talk about, a little bit about the tools we use in hydrography, as the Technology Working Group.

So we're going to try and explain what's a fairly technical subject, but we're going to attempt to do it in plain English. And I'm going to pace around and wonder around, so that I don't far asleep, far less you guys.

So, let's see. How am I supposed to point somewhere specific? The button in the middle?

(Off microphone comment)

MEMBER LOCKHART: Yes, that's what I'm hitting. Okay. So, we have, I have a lot of graphics in here. And actually, some of them are pretty old graphics, but they are still applicable so I'm going to use the old graphics.

Some of the graphics I got from the Army Corps of Engineers down at JALBTCX. This is the Joint Airborne LIDAR Bathymetry Technical Center of Expertise. They've been doing LIDAR bathymetry along the shoreline for some years now.

And I also got some graphics from CCOM. So thanks to you guys for that.

I didn't reach out to Mike and get graphics from him, I probably should have done that so I had some more up to date information in here. But he gets to brief you guys all the time, so.

Man, I'm standing in just the wrong place, I think, for this.

MEMBER SAADE: The battery might be low.

MEMBER LOCKHART: The battery might be done, yes. Here we go.

So, let's start about, start looking at the operational concepts. Why do we want to use bathymetrical LIDAR?

We're all aware, when we're on a vessel and we're trying to survey with multibeam, we're getting a corridor of information underneath the vessel. And that corridor of information becomes smaller and smaller as the water depth gets swallower. So it becomes less and less efficient.

Bathymetric LIDAR provides consistent and predictable swath widths. So it makes it a much more efficient technology to survey like a large expanse of swallow water.

And by swallow water we're talking about from zero meters' water depth to around ten or 15 meters. Beyond that it's still actually pretty efficient to survey with vessels.

And certainly, if you're doing object detection would better be using a vessel beyond 15 meters water depth.

So if we were to compare a LIDAR multibeam densities for, say five meters water depth, you're going to get more dense data with multibeam, but it's not as efficient. And you certainly get plenty enough dense data with the LIDAR system.

And certainly the LIDAR is going to give you a much more fully picture of the seafloor than doing a single beam survey in that same environment.

The LIDAR also has a benefit there. It limits any safety concerns of operating vessels in shallow water. Sometimes uncharted water.

And you can also do a LIDAR survey where it's just not practical to do a vessel survey. So in shallow water river environments, environmentally sensitive reef areas, in remote and areas that are hard to get to with a vessel.

And I'm going to skip that last bit because we're time limited.

So bathymetric LIDAR has been around for a long time. It's been around since the '70's. It mostly started with Military applications for submarine detection and mine detection.

And only in the past 15 years or so we really started to use it for regional mapping and for hydrographic mapping purposes.

The general -- we're not going to go through all the sensors here -- but the general trend has been that the systems, as they've progressed, have decreased in size and weight, which means we no longer need dedicated aircraft. We can put systems in an aircraft that have a standard camera hatch.

And as they've got smaller and lighter, they're capabilities have increased. We fire the laser faster so they have high pulse repetition frequencies.

And what that means for us is denser data and wider swath widths. But we've also added additional sensors to the system.

So now typically most systems are running with a camera. Some sensors are also running with a hyperspectral sensor. We're getting topo LIDAR as well as bathymetric LIDAR. All from a single pass.

There are some anomalies to that. And we can see that if we look at the JALBTCX LIDAR program.

They started surveying in 1994 and the laser was firing at 200 pulses per second. As time has gone on, they have basically increased how fast the laser is firing, so again, we're getting denser data, wider swath widths. And they've increased the capabilities of the system.

They started off in 1994 just collecting bathymetry on a tidal datum. They had to have a tidal datum. They had to have tides.

As the years progressed, they added the ability to survey on the ellipsoid, which also allowed them to then collect data on land as well. Then they added a camera, they added a spectral imager.

The CZMIL system came online in 2012, and that's the system they run now. Both the Army Corps and NAVO run that system.

It's the anomaly in that it is not a smaller LIDAR system, it is a behemoth. But it does do everything from bathymetry through to spectral imagery.

And the idea of that system was to be able to do data fusion. There is debate on how successful it is of that, but it is out there.

So some of the current sensors, we can basically split current sensors out there into two categories. There are, what I sometimes refer to as traditional or high-power sensors, they're basically deep channel sensors.

They can see twice as deep as the other category of sensors, which are the lower-power sensors.

The deep channel systems, some of these have been around for a decade. The SHOAL and LADS systems both are, Fugro runs both of those.

And then the newer deep channel systems, the Optech CZMIL that we just briefly discussed, and Leica have a HawkEye III. Those two systems both have methods to get denser data in shallower water, as well as collecting deep channel data.

The low-power systems have basically one thing in common, and that is, they are using less power so they're very much smaller than the deep channel systems. They also have the ability, because they're putting less power out in each pulse, their beam divergency isn't as large. And so their footprint size, when they hit the sea surface, is a lot smaller.

So in general, we're getting denser data from the low-power systems, but we're also getting more accurate data from them.

And most of the, we're not going to talk about the first two sensors on that list today, we're mainly going to talk about the Chiroptera II, which is a sensor we run, and then the Riegl sensors, which Mike runs.

All of these sensors run under a similar operational theory, so we're just going to backtrack and explain how these sensors actually work. All of these sensors typically have some kind of near infrared laser or a topo laser. And also, a green laser.

The older systems used to do this by using a frequency doubled ND:YAG Class IV laser. But nowadays the trend has been to use independent lasers. And there's actually a lot of benefits to doing that, which we'll discuss as we go through this.

In all cases, the laser is basically firing against the scanner mirror that's moving around, or a circular palmer scanner, to create a swath of points as the plane is moving along.

So the green laser is the one that we're actually using to measure the sea bottom. It basically hits the surface, it goes through the water column and we get a return from the seafloor. But we're also getting information from the sea surface and all the way through the water column as well.

The infrared return is the one we're using to get a better identification of the sea surface. It does not penetrate the water, it reflects off the water, so we can more accurately measure where the sea surface is there.

The older systems also had a way of measuring the sea surface called the Raman return. That's not actually used in any of the newer systems. And there are issues with using it.

It's basically caused by the green molecules getting excited right below the sea surface. And there's some elastic stretching.

And it actually gets returned to the sensor as red energy. And that can be measured to indicate where the sea surface is, but it's a volumetric return that's coming from slightly below the sea surface. And we don't know exactly how far below the surface it's coming from, so that adds inaccuracy into our data if we use that as a surface return.

However, it did serve a purpose when the sea is flat glassy calm, the infrared pulse will bounce off and we may not get a surface return. And so the Raman return was actually really useful in those instances. Because a return is better than no return at all.

So when that green beam comes down and it hits the water surface, there's a lot of complex interactions going on with the water surface. And then there's a lot of complex interactions going on as that light travels through the water column.

As the light is traveling through the water column, it's scattering, it's being absorbed. There's a bunch of volume back scatter going on before it hits the seabed.

And this graphic is used a lot just to show all of these complex interactions. But if we look at this in a slightly different way, this is time going along the bottom here.

So when the green beam enters the surface, we get a big return off of the surface. Typically, not always. But typically, we get a big return off the surface.

And then as the green energy is going through the water, we get a lot of volume backscatter. And then we get a stronger return again off the bottom return.

In reality, the bottom return is typically much more weaker than the surface return. But again, I say not always.

In very clear water, and especially

with these lower-power systems with smaller footprints, sometimes we get a lot weaker return off the surface in clear water because it's not as obvious a boundary to the system. And so sometimes those bottom returns, in clear water areas, are actually strong than the surface return.

Some differences between the sensors. Some of them have different scanning patterns. There is a trend now towards an elliptical scanning pattern. And most of the sensors we use nowadays actually use a full elliptical scan pattern.

There's a lot of benefits to that, and we'll describe those as we'll get some data examples here later. But the main benefit is you're getting multiple look angles in a single pass.

So you're looking forward and then you're looking backwards behind you as well. All from the single pass. And that has a lot of benefits, which we'll discuss.

The CZMIL system that the NAVO and JALBTCX guys use is a little different than every other sensor. Every other sensor, as sensors have progressed, have used a laser that fires faster to increase their data density.

The CZMIL system is using elliptical scan pattern, but it actually uses a technology called segmented detection. When the light returns to the sensor.

So they send out a single pulse every 10,000 times a second basically. But on the return of that signal, they split that light physically and they go into seven different channels and they get seven different returns.

This only happens in the shallow seabed and on land, to increase their data density there. They need a wider field of view to see deeper, so in the deep channel they're only getting one return per outgoing pulse. But in the shallow channels they're basically getting seven returns pulse.

Like I say, every other system does

that differently. They basically increase the rate of fire to increase data density.

And there's a lot of arguments for what's the best approach, but I think we're starting to see that the best approach is just to fire the laser faster.

Deep channel sensors have to have a larger beam divergence. And it's not because they, they could have a smaller beam divergence. There's a lot more power in each pulse as the laser is fired. And if you don't diverge the beam, you will basically blind everybody on the ground.

So it has to be, the beam divergence has to be larger for eye safety. Blinding people is not good for business.

So that's why these low-power sensors are able to use small footprints. There's not as much energy in each pulse.

Now, what that means is they don't see as deep into the water column. The deep channel sensors will see roughly twice deep as the shallow channel sensor.

But depending on the project, depending on the water clarity in your area, you have to pick the right tool for the job.

Now historically, shallow water discrimination has been a problem for bathymetric LIDAR. These systems that have larger footprints, and these are wave fronts from a SHOAL system that I got from JALBTCX, the problem in shallow water, and we're talking about very shallow water, about zero to a meter in a half water depth.

In the wave form you get a very clear surface return and then you get a clear bottom return. So there's two humps on that wave form, on the very left there.

As we come in shallower, those two little blips on the wave form start to merge together. And it's really hard to discern between the two.

Now, what that means is it's hard to calculate the depth. The way we're calculating depth with these, is basically measuring time between the surface and the seabed. And if we can't measure that time, because we don't know where those returns are, we can't get a depth.

Now, some of these sensors got around that by developing some shallow water algorithms. But the newer sensors don't really have that problem.

So again, we'll look at a comparison between CZMIL and the SHOALS. This is an actual SHOALs wave form. It's from Ft. Lauderdale in 25 meters of water.

The water is relatively clear here. You can see the surface return, you can see the bottom return.

If we put a CZMIL wave form on top of that, it's exactly the same seabed, reflects the same water clarity, same water depth. You can see that there is a lot higher signal coming from the CZMIL. It has a better signal to noise response than the older system did.

And there is also a shorter system

response time. So we can discern those blips a little easier.

So if we look at the same thing in shallow water, so this is the same thing in a meter and a half of water, the black line is the CZMIL system, which has a shorter system response, and you can see that it's very clear to see the surface and the bottom return, and it's a lot harder to see it in that red wave form, from the older system that had a longer system response time.

So we should be able to, with better signal to noise and better system response, be able to detect the bottom, not only deeper, but also do better in that shallow water region.

And this is just another example of the same thing. It's a Chiroptera wave form in 1.2 meters of water against the 29 nanosecond response time. Which is basically the SHOALS response time wave form.

And again, you can clearly see a surface versus a bottom return.

So if we group all these sensors back together, I think basically what we're trying to show here is the flying speeds, the flying altitudes for all of these things are very similar.

Now, the swath widths are actually fairly similar too. But the main difference is these low-power sensors are smaller, they're lighter, they're firing the laser a lot faster.

In case of the Riegl, it can fire up to 550 kilohertz. I don't think anybody is using it, firing it that fast. Usually 125 to 250. But they're getting a much denser data than the deep channel sensors.

I want to talk a little bit about accuracy. All of these systems basically say they meet IHO Order 1. Jon Dasler there just mentioned that that's not really good enough anymore for some of the things that we're about doing.

In our experience, our accuracies are actually a lot better than that in these newer sensors.

So almost a decade ago, when I was still at Fugro and Ed was still at Pelagos there as well, we came up with a way to empirically measure our uncertainty over LIDAR sensors. And we're still using a lot of that similar methodology right now to measure for our sensors.

So this graph is basically showing, the black line is the allowable uncertainty for IHO Order 1. The red line is IHO special order. The blue line are actual calculated vertical uncertainty for either the Chiroptera or the HawkEye III. They're basically the same sensor.

And as you can see, it's actually below special order. The accuracies we're getting with these new systems are far better than actually I really ever expected to get from a LIDAR system.

The green line underneath that is basically the root mean square error. Because in the topo LIDAR world that's how they like to talk about their accuracy rather than using uncertainty. So I just devolve it down to the RMSE.

But the RMSE has basically gone from five centimeters to just under 18 centimeters in 50 meters of water depth. Which is pretty incredible.

And that five centimeters, or ten centimeters' uncertainty on the front-end, is the static error in that IHO equation. So we have an error that's not dependent on depth. It's basically the error that we're getting from our source datums and our datum transformations, before we ever go below the water surface.

So looking at these systems, this is the biggest system and the smallest system currently operating. The CZMIL is large. It's maybe not clear how large from this image.

The LIDAR sensor head there is just over a meter in height. It's huge.

They have done a pretty good over the past year or so of reducing the size of the thermal unit and reducing the power requirements of the sensor. So it's a little bit smaller now, but it's still the biggest sensor out there.

The 820-G, I think mostly in the U.S. these have all been switched out for 880-G's, but the 820-G is probably the smallest sensor running out there right now. It doesn't see as deep, but it served a purpose and got us to what is now a pretty good sensor in the 880.

Leica took a little different approach. They made a modular sensor design. So they start off with a shallow bathymetry in the Chiroptera so it has a fully functional topo laser and it has a shallow bathy laser.

You can then just add a deep channel to that, and they call it a HawkEye III. But it's essentially the same system with a deep channel added. You can also pull the shallow bathy laser out completely and turn it into a fully two-head topo system.

So if we look at those systems, this is the Chiroptera system. So on the left you see the controller unit and the electronics. We have the operator display and then the actual sensor head. It's sitting in the gyrostabilizer mounts.

And then the deep channel, if we add the deep channel to that, so this is the same thing but with the deep channel added. That deep channel is huge.

So you can see the increased weight, the increased power required to get twice as deep in the water column. It's a lot more effort. It's going to have to go in a different aircraft. The aircraft is going to have to generate more power.

So operationally, when we think about using LIDAR, the first thing we have to do, when we're given any survey areas, decide if it's a suitable tool or not. It's not always going to be a suitable tool. And we don't want to use it where it's not suitable. Nobody wants an unsuccessful survey.

So we have to think about things like water clarity, seabed reflectivity, the weather, the expected terrain and what depths. If we think it's going to work, what depth do we think we're going to get to.

A successful LIDAR survey, if you can't penetrate to that expected depth, it's still not successful. Even if you got a little bit of data. If you didn't get to the depth that the client needs to see to, it's not a successful survey.

So we have to try and figure out what depth we think we're going to get to, before we ever go there.

So the depth penetration depends on the water clarity, sometimes referred to as turbidity. And it also depends on the seafloor reflectance.

We're dealing with light. Light gets absorbed by dark surfaces. If the seafloor is dark, it will absorb the light and we will not get a return. So we have to know these things.

In general, the high-power sensors see two to three times the Secchi depth. It's kind of of an easier, user friendly way, to think about water clarity. There are more mathematical ways to do this.

Low-power sensors, this slide is wrong. Low-power sensors get to usually about one and a half times the Secchi depth in general.

A Secchi depth is basically you take this little white disc, that you see there, you lower it into the sea until you can't see it anymore, start to pull it back up, and when you see it again, you measure the depth of the rope it's hanging off of and that's one Secchi depth.

Basically, you see one Secchi depth with your human eye. So a passive sensor, like a hyperspectral sensor, is going to see to one Secchi depth.

So if a client has Secchi depth for an area, that's really useful when we're trying to figure out if this is a suitable tool or not. But there are other ways to get that assessment if you don't have Secchi depth information.

So one of the things we do is we use AquaMODIS satellite imagery. We look at the historical imagery.

They have a diffuse attenuation information at 490 nanometers, which is really close to the 532 nanometers we use bathy LIDAR. So it can give us an indication of how deep we think we're going to penetrate the water.

And so we'll look at monthly data over a number of years and try and figure out if there is a best season to go and survey somewhere.

There are other areas where seasonal assessment isn't as useful. It maybe that the tides and currents are more important.

Sometimes we can get a really successful survey if we go and survey it slack tide. At slack tide, the sediments drop out the water column and lay on the seafloor and we can get great data. But if we try and survey in that same area, when the tides running or the current is high, that sediment is back up in the water column and we cannot penetrate that water column to see to the seabed.

So you have to think about all these

things and look at the environment you're working in. Or going to be working in, to see if this is the right tool for the job.

Likewise, we have to look at temperature because temperature basically effects whether you're going to have to use an air conditioner in the plane or not.

If you're using a deep channel system that requires a lot of power, and then you know you're also going to have to run an air conditioner. That's going to affect your aircraft choice, it's going to affect your cost.

We have to look at wind to see if it's going to affect the crabbing angle. If you're going to crab the plane along a line, it's going to affect your effective swath width, if you like.

So you may want to plan your flight lines based on the prevalent wind direction, instead of just dumbly looking at how to run the fused amount of lines. You have to take these things into account.

We can't operate when it's raining. In heavy rain, we'll get a return off the rain before we ever hit the sea surface. So not only is that just you don't get any data, if you hit that rain really close to the aircraft it's going to come back up, it's going to fry your detectors. So you don't want to do that.

The cloud ceiling obviously has to be above the aircraft for the same reason. We can't fire through cloud.

And then sea state is important because we can't penetrate white water. Light cannot penetrate those bubbles. And so if the sea state is really high and there's a lot of chop, you probably don't want to go out and survey that day.

That goes also for wave zone areas and river rapids. So there's a lot of things you have to take into account, to figure out when is the best time to go and do this survey.

And once you figured that out, then there is all these other operational considerations. You know, where we're going to base your locations from, do you need a deep channel sensor, do you need the shallow channel sensor, what are the expected depths. And then we have the whole datum issue.

We do get kind of spoiled when we're flying along the coast line of the U.S. We have great data from CO-OPS, great data from NGS that allow us to basically go and fly. We're always collecting on the ellipsoid.

And we can translate that pretty easily into any tidal datum we want. But it's because all that work has been done and the data is available from these organizations.

We do go and survey in other areas ourselves where that data doesn't exist at all. We have to then think about putting in tide gauges. We have to keep them in there for a month or two.

We have to develop datums, we have to develop the swift from the ellipsoid to those tidal datums. Sometimes that's straightforward, sometimes it's not. Sometimes there's not a useful geoid model in the area.

So there can be a lot of complications to doing these surveys, especially if you're working in remote areas. And then we also have to think about air traffic restrictions, flight permits, all those kind of thins as well.

So I think the point is just to say that there are a lot of operational considerations. If you go out and by a LIDAR sensor and go to do this for the first time, there's a chance you're going to overlook some of these details. It may cause you a little heartburn, you'll get there eventually.

So, I wanted to close by just showing some more recent data. This is an example of data off of, it's just actually just off of Port Angeles. It's where the Elwha River empties out and the Straits of Juan de Fuca.

The point of this slide is to show that we are getting data real shallow now. So we have seamless topo and bathy data, collecting on a single pass.

The sensor has a camera on it too, so you've colorized the point cloud. These are actual points, this is not an elevation model.

And we're getting good definition of the steep slopes. We're getting seamless topo-bathy data.

This is another example, again, from the Elwha River. The advantage of the elliptical scan, seeing in multiple directions.

And also, these newer sensors, we get multiple returns from the wave form. So we can get up to four returns from the wave form.

Older sensors, you used to have to choose between getting the strongest return or the shallowest return. Now we get all of those in a single pass.

And what that allows us to do with the elliptical scanner, the multiple returns, is we can see underneath the vegetation. So the green in this slide is basically the ground on the land.

We've got the vegetation in the white and then the slant is actual bathymetry. And in some cases, we're getting very, very shallow bathymetry, but it's good bathymetry.

This is another example where trees have fallen over down that steep hillside, and we have a bunch of logs sitting on the water surface. And, again, we're still getting good bathymetry underneath those logs because we're seeing multiple look angles in a single pass.

Now, I mentioned we can't penetrate white water, but this is one of the advantages of the elliptical scan. There are a couple of seconds between the front of the scan passing a location and the rear of the scan passing that location, and that gives the waves enough time to move.

And because we're also looking in different directions, we can actually get penetration in that white water zone. We're not seeing through the white water, it's just that the white water has moved.

So this is a finalized point cloud again. This is in Florida. So it's been colorized so you can see where the waves are, but that's all actual real usable bathymetry there. Everywhere you see a point, that's a real valid point. So we got full coverage in the wave zone in Florida.

Which you're not going to get that everywhere, but you will get a lot better coverage than you're ever used to.

The detail we get from these newer sensors is pretty amazing. Mike has shown a lot of cool images when he's presented in the past. Along with Juliana.

And the detail really is astounding. But it's not just the detail, it's the detail is also more accurate. And I think that's an important thing to remember. The data is not as fuzzy as it used to be, it's a lot clearly than it used to be.

This is some smaller channels for recreational boaters going into their berths in the Florida Keys. And you can see some of the details as those channel end, where the corral and rock piling up. It's really pretty cool.

And lastly, I wanted to talk about some of the value-added things that we don't always talk about when we talk about bathy LIDAR.

So this was a project. It was a demonstration project we did off of Germany, quite a few ago now. It was using a Chiroptera sensor.

And we have about eight lines of LIDAR data in here. The area was a lot larger, I just pulled out a snapshot of it.

We're going from very, well, very close to land. The land is actually right in the bottom right corner in the kind of pinkish hue there, to about eight meters water depth in this image.

But we don't just get depth, we also get the intensity of the return. So we can look at the reflectance of the seabed and we can start to use that to think about what is there, what is on the seabed, what type of seabed is this.

In this case, they were interested in using this technology to map their seagrass. They wanted to know if their seagrass beds were growing or if they were depleting.

Now, it's not quite as simple as this, there are challenges to doing this. And it is a little bit academic still.

What you start with is raw intensity. And as the signal is going through the water column, there are losses associated with that.

And so as you get deeper, the signal return is getting, is essentially getting darker. And so you have to correct for that, because the raw intensity is not just the intensity of the seabed, it's effected by the water column you're traveling through.

If your water clarity changes, you will get a different answer than if it was clearly the day before. So you have to correct for all those things before you can really use this as the actual seabed reflectance.

But once you have that and you've normalized for depth and the water clarity, you can use this to try and classify the data.

So we had digital camera imagery off of the sensor too. So in the very shallow water we could, we didn't have any ground-truth in this case, so we tried to identify ranges based on where we know there was seagrass in the real shallow areas, from the RGB imagery.

Picked a range of intensity, so we thought delineated seagrass, and then used that to classify the image. Then we changed that to vector, and used that vector basically to classify the raw LIDAR point clouds.

And so if we take a look at the cross section through this area, this is basically, the bottom image here, the dark blue, is essentially the seabed that doesn't have seagrass on it. And the cyan color is essentially where there is seagrass.

In this case, the seagrass was only 25 centimeters high. That would have been really difficult to detect some other way.

So we did this three times, I think, over the course of three years. Not always in the same season.

And it was possible, even with no ground-truthing or anything else. And this is a fairly rudimentary way to do the classification. But it was fit for purpose and it was kind of an interesting project.

Finally, I did mention there are other sensors on these systems nowadays. We always run within our CD30 camera, for example.

So we can do true color imagery, we can color infrared. Or you can do an NDVI image, which gives you information on vegetation health.

Purely by accident, we actually created one of these images that crossed into water, and the water was relatively clear and we could see algae growing in the water column. We haven't really looked into that anymore to see if that's a useful thing or not, but it was just kind of a curiosity that I thought I'd mention.

And finally, I'll leave you again, with another image of the Elwha River coming into the Straights of Juan de Fuca. That is not a photograph, that is a LIDAR point cloud.

So the detail we're getting from this data now is truly amazing. It's far better than it was a decade ago. And I think that's kind of the point I want to leave you with.

I've kind of skipped over talking about object detection and other technical things, I'm happy to answer any questions anybody has on that, if they want to get more technical. But that is it, I'm done.

(Laughter)

(Applause)

MEMBER GEE: Any questions?

VICE CHAIR MILLER: I would like to hear a little bit about object detection. I recall several years ago working at the New Hampshire website and going, you mean it doesn't detect rocks, because they were dark I think.

What's the status of that? And how

does it integrate to object detection needs in IHO and so forth?

MEMBER LOCKHART: So there were some challenges with the older systems that had those larger footprints and the data wasn't as dense. And so when we got in shallow, there would be a footprint here and then there would be a footprint over here. And there would actually be a gap between those two footprints.

So you weren't actually eliminating the full seafloor. And so that was one of the problems with the older sensors.

And then those, depending on the system you are using and how you used it, you know, the larger footprint kind of mushes out the seafloor a little bit, so you weren't always seeing the shoalest depth.

Could they do object detection? In the right environment, yes. But you have to be very careful about where said you could do that.

And I mentioned earlier, if you're going beyond 15 meters of water, you better not be using any LIDAR system and claiming you're doing object detection. It's not going to work that way because that footprint is going to spread as you get deeper into the water.

But now with these, with the much denser data that we have, the data is more accurate now. We do object detection. We basically do.

You're going to have more challenges with it per water clarity, but because the data is denser, it's going to be more obvious where you have a gap in your data. If you didn't get a return, then you can't claim there's an object there or not. You're just going to say, I don't know what's there. And those gaps are a lot more obvious when you have denser data.

But actually, the last two years, most of our work, and our company has been doing this for nautical charting purposes, and we are doing, some of those surveys are Order 1a, or Order 1b, and don't require object detection, but a bunch of them are Order 1a and they do require object detection. And we are doing that and we are certifying that we are detecting objects in those areas.

Now typically, if we're doing object detection, you will still fly to go 200 percent coverage, because we want to pass over an area twice. Because sometimes it is hard to resolve whether there something is a shoal of fish that's just moving through or if it's an actual object. And so we like to fly at 200 percent just to give us that comfort factor.

But yes, the bottom line is now it's really easy to see where you are missing data, and then you don't know what's there. Rachel.

MEMBER GEE: Rachel.

MS. MEDLEY: Hi, Rachel Medley, Office Coast Survey. Carol, you mentioned about having to do sort of a lot of prep and recon before you go out and determine, are you guys employing satellite-derived bathymetry as sort of a preliminary recon tool or are you using that in conjunction to validate or --

MEMBER LOCKHART: We have. Actually, we have done that too. And sometimes that can be pretty useful. But we don't do it all the time, in all honesty.

And a lot of times, now our clients are getting a lot smarter so they're not necessarily giving us those areas where it's not going to work anyway. So it's a little bit less of an issue.

And then satellite bathymetry doesn't really work when we're doing stuff really close to shore and rivers. And in complex environments the detail isn't there, from that imagery, to tell us what we need to know.

But yes, we have. We have done that in the past.

MEMBER BRIGHAM: Yes, I mean, Ed and Carol, and maybe even Lindsay can comment. I mean, it's great technology. It's hard to apply to Alaskan waters because we have the complexity of everything you talked about, Carol.

And so the prep work, it makes it

hard. I mean, you got sediment all over the place, I mean it's a very --

But for specific jobs, like putting pipelines on the seabed and whatever and looking for ice scatter, and all of that stuff, I mean, hugely important.

But I suspect the preparation to do an area, in Alaska, the prep looking at ocean currents and all the sediment, and looking at satellite imagery, be hugely important, is really a lot of work.

MEMBER LOCKHART: Yes, that's true, Alaska is definitely a challenging environment. And one of the challenges of Alaska is just the shorter survey season. It's a shorter survey season if you're on a vessel.

It's an even short survey season if you're trying to do LIDAR, because the clearest water clarity is right after melt. And then as soon as you get a few days of sunshine, the algae blooms and you can't do anything.

So you have to hit that window

perfectly. It can be done, but you really, you have to nail your planning. And sometimes you just get lucky and sometimes you don't.

It's definitely a challenging environment to work in. It can be done, but it's not easy. Ed.

MEMBER SAADE: So we've been there a few times in the past and got huge data sets. One of the efficiencies was to intentionally pick a couple of three locations. Far apart from each other. Hundreds of miles apart from each other.

So that you could take advantage of the aircraft legs and be able to, maybe you are shut down in one portion of the state and you can go off to another part of it.

But we also used it pretty extensively as a recon tool, in complex areas, to be able to bring the small boats in, in a much more safe, confident matter. And that worked out really well.

MEMBER GEE: Question here. Scott.

MEMBER PERKINS: Yes. We've seen a

really paradigm shift with the technology on the terrestrial LIDAR. With the Geiger mode and the single photon, in that change in technology.

Is there a similar change in technology that's going to impact bathymetric LIDAR?

MEMBER LOCKHART: I think the biggest change we've seen over the last four years is just that increased data density. From being able to design a laser that can fire a lot faster. And that's a paradigm shift that happened in the topo LIDAR earlier, right?

I'm glad you brought up the photon counting in the Geiger mode. So obviously Sigma Space is running around saying that they have a green laser, they get bathymetry. Yes, kind of.

So they get a return. They can see the seabed, sometimes, if the water is clear. It is not an accurate depth. And that's really important.

When I mentioned those flying altitudes we're typically, the optimum flying altitude for any bathy LIDAR is typically around 400 meters. Above ground level.

And you can collect bathymetry. I mean, we've collect bathymetry just through testing. We'll fly at 1,200 meters high. We still get a return. It's not an accurate return.

It will show us the general shape of the seafloor, but the depths are getting worse and worse as you start to fly higher. And so you don't meet your accuracy spec.

And that's the problem with Sigma Space and some of these other systems right now. Because they have a green laser, it does penetrate the water and they get a return. But it's not corrected for everything it needs to be corrected for. And they're not getting an accurate depth.

Will it be possible to do that in the future? Potentially.

But there are other challenges with flying so high on a coastline. There is always fog, there's always cloud cover along a shoreline. There's actually a lot of advantages to flying at that lower altitude.

MEMBER SAADE: Do you have an opinion on autonomous platforms or timeline?

MEMBER LOCKHART: Wow. Yes, kind of.

(Laughter)

MEMBER LOCKHART: I think we may get there eventually, but I feel right now it's actually a little bit of a red herring.

Because the systems are typically still fairly large. And I kind of look at it a little bit like the AUV world.

You know, a decade ago everyone felt AUVs were going to be the latest thing. Well, now we're starting to see that actually maybe autonomous surface vessels are more useful for a lot of the stuff we do. Definitely AUVs have their place, but maybe shallow water isn't that place.

And I kind of feel like there's a lot of excitement about the unmanned systems right, but the problem with them right now is they don't reduce the number of people you need to have in the field to operate them, so there's no economic benefit to going to that model right now.

That will change in the future, and it will probably change somewhere other than in the U.S. first. That's kind of my opinion.

MEMBER GEE: Okay. We just want to move on, but two more questions. One from Dave and then Gary. So Dave first please.

MEMBER MAUNE: Carol, topographic LIDAR has the quality levels that have now become common place that people refer to QL2, QL1, QL0 LIDAR. And the topobathy and bathy LIDAR communities are trying to come up with bathymetric equivalence to that.

And right now, JALBTCX is promoting the use of the IHO formula that's the square root of A-squared plus B time D-square. Are you familiar with that formula?

MEMBER LOCKHART: Yes.

MEMBER MAUNE: Where the A is non-depth dependent and the B is depth dependent.

When you mentioned five and ten centimeter accuracy on one of your charts --

MEMBER LOCKHART: Yes.

MEMBER MAUNE: -- was that an RMSE number or an accuracy at the 95 percent confidence level?

MEMBER LOCKHART: The RMSE is five and the 95 confidence level is ten. And that's basically coming, that number we're starting with is the non-depth dependent part of that.

MEMBER MAUNE: Yes.

MEMBER LOCKHART: So it's the A number in that formula.

MEMBER MAUNE: yes.

MEMBER LOCKHART: And it's coming, typically, from the errors we know exist in our source datum. Whether that be the ellipsoid or something else. And the transformation we have to do to get to our tidal datum.

MEMBER MAUNE: So the --

MEMBER LOCKHART: Or our orthometric datum or whatever. The error that exists in our

GI model.

So that will change a little bit. This is just kind of a nominal number that we came up with for our system, for where we've been operating.

But yes. I mean, they're working on those QL levels for the topobathy.

I think that's part of the problem they're having right now is not everyone has done a good job of actually measuring the uncertainty in their sensor. And so we're starting to pick numbers.

And maybe our sensors don't actually fit within those numbers and we may be setting ourselves up for failure. I think people are starting to look at that in their sensors now.

And there's certainly been a lot of push, and NGS is a huge push to try and develop TPU for their Riegl sensors. And there's been a big push in the academic industry to try to do that.

But this has been going on for years.

I mean, that was a decade ago that we came out with the empirical way to do it. And we did it empirically because there was no way to do it at the hardware level.

I mean, this has been going on for a long time now. We do need to understand the accuracy of our sensors better so that we can start to talk about quality levels in a more meaningful manner.

MEMBER GEE: Well, if you are confident that you can achieve elevation accuracies of ten centimeters at the 95 percent confidence level, that's pretty good.

MEMBER LOCKHART: Yes, I think so. I was amazed to be honest.

MEMBER GEE: Gary.

MEMBER THOMPSON: So just to follow-up on Dave's. So with QL1 and QL2, we do independent QC points to verify it.

MEMBER LOCKHART: Yes.

MEMBER THOMPSON: So with underwater, a little more difficult, so how do you verify your accuracy?

MEMBER LOCKHART: It varies by client. So some clients don't want to pay for independent QC so there is none.

Our clients that we've been doing all our nautical charting stuff for, for the past couple of years, we have gone out and collected multibeam patches in various areas.

We collect hat multibeam on the ellipsoid using the same methods, so we're comparing apples to apples. In very shallow water, sometimes we'll just go out and wade into the river.

We've developed our own autonomous surface vessel, that's a little tiny portable version, that we can go out and go, we can put a single beam or a multibeam on it and go out and collect some datums without putting somebody in the water, to try and just get some ground-truthing too.

But we also ground-truth it on land. And we calibrate over land, actually, for all of the channels. Both the bathy channels and the topo channels.

MEMBER THOMPSON: So over land do you have, you depend totally on our GNSS IMU or do you have ground control points that you use?

MEMBER LOCKHART: Over land we always have ground control points. We can calibrate the angles and do all the boresighting with goals, but there are some timing issues that we need to take out of the sensor or we need to make sure that we take out of the sensor base. And that's largely based on the length of the fiberoptic cables.

So if you change that fiber optic cable, those timing things are going to change. And the ground-truth helps with making sure you have those right.

MEMBER GEE: Okay. Thanks, Carol, that's great.

PARTICIPANT: Thanks.

MEMBER GEE: Thank you.

(Applause.)

MEMBER GEE: I think we have about 25 minutes left, I think, through until the public comment time, but that can be, I don't think we'll have any public comment until after we finish this.

The next stage was the -- if we can go back to the PowerPoint, that was the first one again.

I would like to stand up too, but I don't think I'm capable of standing up and holding onto a microphone, so I'm going to stay and sit here. I'd probably drop it.

Yes, so this is just a brief summary. What we're going try and do was some of the -- just give you a summary of the activities of Technical Working Group over the last, last almost year now. Just over a year.

And we started with trying to -- I guess it was to understand what were we going to do and how can we contribute. And we really wanted to get a feel of, one, how can we contribute.

We don't really know what's going on at NOAA, I guess, was one of the things. We wanted to get some briefings about what was happening so we could comment.

And then also to get just some industry input about what they might be doing that might be applicable to that.

So, one of the other things I think is what we've seen is across, and as I said earlier, the technology is across all of the issues papers. And so we tried to contribute to most of those.

There is, and Ed and I will discuss this at the end, we put a draft around about a technology transfer paper or the benefits of technology transfer we've seen so far. And then just a brief at the end, what we think is next.

So as I was saying, the Technology Working Group was --- Ed put together the terms of reference and it was like, yes well, we wanted to contribute in some way and recommendations, advice, all those things. But it was really we had to understand that first.

And so that was, then moving on to the monthly meetings. We tried to do it mostly monthly, but I think it's a struggle sometimes meeting that.

We have other meetings now, and maybe that's something we can discuss at the end of the --- tomorrow, about there are a number of meetings and doing it monthly might not be realistic.

They were, kind of started with a reasonable attendance from others in the HSRP. And I don't think we started as just for the Technology Working Group, we hoped that they would be available for everybody and some people would come when they could, but I think we acknowledge that's not easy. So we would like everybody to let us know on that.

We had an initial meeting up at the, when JHC/Center for Coastal and Ocean Mapping had their annual review with NOAA, and that was our first meeting. We went on from there.

We move on and just go through. What I was going to do was just go quickly through the meeting so you've seen who we've talked to and what we've done.

The first one up there was John Hughes Clark, presented about, he was on the independent, what's that called, the fleet review, which is out now. I think it's published. So I actually haven't read that.

But he gave us, specifically about his contribution to the, into that about sonars and what the goals were. And it was good to see.

I think there was nautical charting and that habitat, you know, that combined, here we are mapping for mapping, not just for nautical charting.

And there was certainly focus in what he presented to us, was about autonomous systems. Which I think is a thread we're seeing. And then the paper for NOAA, we can comment on that later.

Please, if anybody has any comment as I go through this, quickly, please interrupt and let me know.

The next one we then, then being the precision navigation. There's been discussions about that. And this is, yes, it was the same, we didn't have contact.

We had Neil Weston actually present it, I'm not sure, you were aware, I think, Rick, or you got Neil to present?

CAPT. BRENNAN: I augmented Neil.

MEMBER GEE: You augmented Neil presented. You don't want to talk to us, just say it.

But there had been other presentations and so that was sort of one of the, it was good, because it was when that precision navigation paper kind of started. When Sal and Anne kicked that off.

So it was interesting to see the presentation about the reasons for doing that and what was done and how, in particular, the customer engagement I think was an interesting part of the presentation.

Again, I think coming from the business side of that, I think you have to be careful to separate out customers and users. And as we move into the new -- like, everybody is a chart user, but one of your biggest customers actually might now be those commercial portable pod ECDIS systems. So your users of the data.

And what they produce is the mariner or the recreational pilot. But the products, let's say a recreational boater, in the future may never be, they may not directly be our client.

If you're talking a business sense, the channel might be through an integrator and a distributor of those systems. So I think that's something to also think about as we move forward with that.

Rick then did present, well, I didn't want to present twice in a row, that was what it was, Rick presented. And we're trying, working through the data here.

So it was interesting, we went from,

John talked about systems on ships, then we talked about, where we jumped to the end, the precise navigation, but then came back to Rick, presented about the quality control of the data that comes from the, both the ships and also the contractors.

And working through from the grid of data and some tools they've generated, just to fill the gaps of what they need to meet the requirements for nautical charting. So there was the flyer finder and then the feature scanner and those sort of things, just specifically for nautical charting, to get the QC done for that, to then move on to the chart product.

So that was useful to see that. Interesting to see, I think, that there are still tools that need to be built to support the --- internally.

And I actually talked to E.J. during the break and I think we had -- Neil was associated with the working group, but we'd certainly like, I think E.J., to be now associated with, however that works, with the work -- Technical Working Group, as we move forward.

Cleveland, I couldn't make the second meeting, but I was virtually there for 20 minutes, I think. And I was out on the Nautilus doing a survey.

But it was kind of interesting, because there was a couple of issues that were dealt with, that we were surveying and mapping seeps off the west coast. And I was able to call in and show you what was going on because of the telepresence.

We've heard about the communications and what we can do these days. And I'll mentioned what Ed and Fugro have done, but it really is happening now. And NOAA themselves are doing this.

The Okeanos. The last cruise they did out in Western Samoa, the survey, the lead mapper was running it out of the CCOM Lab. And so, I mean, he was running -- they actually had people onboard, but you could get onboard and change the settings for the sun or on those things.

So this is an evolution that is happening now. And I think the technology that underlies that is there already and we're doing it.

Dickie Martin who's the lead, what's his position now?

PARTICIPANT: He's the head of the R&D.

MEMBER GEE: Head of the R&D in Lafayette. He presented on some of the things that Fugro is doing. And very similar, it was about the current technology.

We went through a bit of history on the technology, but hey, we're moving forward now. And certainly that underlying architecture and all the technology that's supporting.

And it's interesting to see Fugro as the commercial, largest survey company, I guess globally. And really, it's different.

What we are talking about with Martin

early, it's the real business decisions driving the way the technology moves forward. And I think that helps both government and industry in reviewing that.

And one of those was the MH370. Where it was driven that they needed to get the data back for analysis by the Geoscience Australia and others, to make sure that they were getting through the data, and if there was any targets there they could find them.

And then that was getting the communications to be able to send the data back, to allow that to happen. You know, pseudo-real time next day kind of thing. And that was interesting to see that, again, in that.

And then moving through the big data, how automation is part of that and how we need to keep driving that. And again, driven for a very commercial, commercial reason.

We then went from QC to the database. Kurt Nelson and Marcus Cole presented on some work they're doing on a prototype database on

Puget Sound. On the NOAA database, up in this area.

And again, I understood it was kind of a bathy database specific -- well, navigational bathymetric database. So that was for a particular purpose.

And it's interesting, and I guess that there's further discussion of other databases and how that fits. Now we're talking about having that database-driven solutions. So should the database be a navigational bathymetric database or should that be something else?

But I think that was interesting to hear, how that's going and potentially supporting both general charting and the precise navigation.

Just so we did, and I think I said earlier, we have concentrated on the Coast Survey side of it. But I think we're fortunate with Gary's -- the paper he presented was really related to NGS.

And from -- oh, Rich is gone, but we did do something for the, I think, the CO-OP side of the house is up in the University of New Hampshire, John Kelly is embedded up there, and he's been working with the nowCOAST, and does some of those predictions.

And it was interesting to see, again, Larry presented some of the dynamic versions of how being up there, the research has kind of gone straight across into this. And I think the advantages of him being there and being involved in that, we're seeing immediately transfer and being useful for NOAA.

And he was also involved with some of the precision navigation experiment out in Long Beach. So I think that was interesting.

Let me leave that for later.

VICE CHAIR MILLER: I just have a question, Lindsay.

MEMBER GEE: Yes.

VICE CHAIR MILLER: Are all these present, or maybe to Lynn, are all these presentations available on our website?

MEMBER GEE: No, just let me, I'll

answer it. I was thinking about, as I'm going through these, I thought, yes, we better get those up on the website sometime.

So I have them all now and it would be really, that's a really good idea. I'll make sure they get put up. So, Lynn, I'll talk --

(Off microphone comment.)

MEMBER GEE: Yes, I think I've got them as PDF now so I can put them all up.

VICE CHAIR MILLER: Yes, I think that, especially for audience that hasn't had a chance to see these, that it would be valuable.

MEMBER GEE: Yes. We weren't quite organized enough to -- actually, Lynn had created a space for us, but we hadn't put it up for us. So I apologize for that.

The next one was to just get a feel of a large survey, and it was related to contract surveys that NOAA does. And this was Penobscot Bay survey up in Maine. David Millar presented on that.

And maybe Ed wants to comment. Yes.

MEMBER SAADE: So, Rachel, here's the answer to your question. Yes, satellite derived bathymetry, bathymetric LIDAR and then topo LIDAR and then the acoustic systems onboard the vessel. All to enhance the data set, but also to make it more efficient.

Because you could use, as you step from left to right, before you get the vessels in the water, you again find a much more efficient way to approach the survey.

MEMBER GEE: Yes. So that was what was done up in Penobscot Bay. I think you're going back again this year.

MEMBER SAADE: Going back this summer. Yes.

MEMBER GEE: Summer. Then finally, the last one we had at just the start was before, was John Nyberg. Just gave us an update on the charting and the current progress with that, and then looked at the transition from the NCS2 to ENC First.

And then also an update on the load of

the charts into the NIS. And also, then gave us a quick summary, which Travis has done here for us all, about the charting plans.

So that was kind of the summary for the, and I think we covered a lot. Just to get a bit of mix of both us, understanding what activities NOAA were involved in that we were not aware of. And it's really hard.

And we're kind of cognizant of being, as an Advisory Panel, we all love technology so we like to get to the weeds, but we realize that's not kind of our role. But, yes, we can't help it sometimes, so we have to do that.

So out of that there was, I guess there were some themes that, there were others, that we want to talk about. So automation and autonomy was certainly something that was -- and now we have that. So it's kind of appropriate, I think, that we continue that.

And I'm not sure how we respond. I think there's a, maybe that's for tomorrow to discuss this further, whether it becomes an issue paper or how it's addressed.

MEMBER SAADE: There's no tomorrow.

MEMBER GEE: Oh, this afternoon, sorry. Yes. Yes, not tomorrow, this afternoon.

We have to respond to Shep, I guess on that, in how we decide we want to do that. But it was certainly a theme we saw from, right from the beginning of autonomous systems in ships through to the Fugro real drive for lots of big data, its automation in processing. And right through was still a really big driver.

And I think I mentioned it briefly the other day. One, this is all about data gathering and automation on autonomy there, but I think what we haven't mentioned is autonomous ships that are going to be navigating the world soon. You know, we might not like it, but it's coming.

And I think that's where it's great to see the human/computer interaction. And what Larry presents is the way we see it and the way we can analyze the data.

But the other big change, why this

becomes more data driven than products, is there's nobody involved in an autonomous system. So you have to have the underlying data to support the algorithms to be able to make those decisions, coming into a port or navigating autonomous.

So I think that's another shift that kind of adds another point of the transition for NOAA, I think from a product-centric to a data-centric. Because you're going to have autonomous ships. And that's something that you have to support in the future.

So that's something that just is, I don't know how we address, and I don't think that's in the paper from Shep, I don't know, but I think it should be. There should be something that that flows into.

And that's a bit related to the ENC and RNC. What are the products beyond those and how do they tie together. And again, it's the information system.

It's kind of a repetitive theme. It's

the data. It's not the economy that's stupid, it's the data. Sorry.

MS. BLACKWELL: I just want to broaden it a little bit, what you just said about autonomous ships, and broaden it to autonomous everything. I mean, so we're talking land, air and sea.

MEMBER GEE: Right.

MS. BLACKWELL: And again, that's the importance of having that reference that everybody is using. So all those things are connected.

MEMBER GEE: Yes. Both, all in X, Y and Z, right? So, yes, I agree.

MEMBER BRIGHAM: I was a member of the group, but only sat in on a couple of meetings from Rick's brief and Neil's and others, and I'm sitting there as the Chair, in the Arctic Working Group, trying to think, how do we use all these new technologies to enhance the frontier, Arctic frontier. So that's one area.

But I think our Working Group will

take a look at using these technologies and trying to harness some in actually designing a -- or at least have the elements of an electronic coast pilot, that would include bathymetry and lots of stuff.

For not the whole of the United States, but for the area that probably needs it the most, which is Bering Strait, the whole of the U.S. Maritime Arctic from the Aleutian Chain to the Canada/U.S. boarder. So I think our next, kind of a project.

And maybe we can have some ideas, by New Hampshire, on what an electronic coast pilot might look like, and for a specific region, harnessing display technologies and whatever. But putting it in the pilot house real-time.

MEMBER GEE: I think that's something with the -- what you said about specific areas, it's specific areas and customers and segments and those sort of things, is the technology should be there as an infrastructure, to allow those different products now.

So this is the driven data kind of, the recreational boater to someone in the Arctic to, you know, is something we should be able to support better.

MEMBER BRIGHAM: Yes, but of course in the Arctic, where we don't have a lot of data, and we don't have massive -- this is where if you integrate it all in a seamless way and you get it to the pilot house, I think, and we also kind of touch on the integrated ocean management aspect, which is all the sectors, including indigenous people and their use, integrating it all into the pilot house to enhance safety and environmental protection.

MEMBER GEE: Yes. Kim.

MEMBER HALL: I just wanted to say, I feel like I really missed out, based on everything that you went through, with the presentations, I don't think I quite understood how involved the Technology Working Group was.

I mean, we get all sorts of emails so it's not anybody's fault, I just wanted to, I'm bummed. Because I think it's really hard to actually pull these out, when I'm looking at that list of things, as individual things that are only for the -- and I know that the Technology Working Group is now for everybody, I thought it was very much more specific. I did not understand the breadth of what that group was looking at.

But I'm a little concerned because I think some of those presentations that you had, are things that should have been at meetings like this. Or on the monthly call for the full Panel.

MEMBER GEE: Yes.

MEMBER HALL: The precision navigation one, I mean, we really could have benefitted as we're developing that paper.

So I don't know how we have some communication about what's going on, a little bit more directed on here's what's going on. Because again, I don't know how you sometimes can disconnect and say this is specific for technology, because everything is kind of comingled.

But you guys did some cool stuff and I'm going to plan to be a little bit more present, especially if you can do it every other month.

MEMBER GEE: Yes, I know. And I think that's something we should discuss. Because there's a planning engagement.

I never knew that was there. I sort of turned up for half of them. And I wasn't quite sure if that was for the whole Panel or just a specific group.

And again, I think it's the same thing. I learned a lot out of those discussions that I wouldn't have known and so, how, there's a lot of us and how do we corral us. I mean, we all have jobs and those sort of things. So I agree.

MEMBER SAADE: So we met last time in Cleveland, came up with the idea to have the technology session like this, and started with Carol's presentation, which Carol's was great. I think all three of them were really beneficial to the group. So --

MEMBER HALL: I think this is the perfect way to -- I think there needs to be a session that we run, like this, based on what the working groups are working on, because I just didn't know and I am learning a lot. And this is just, what I think these meetings should be about.

Regional information really matters, but also kind of these larger subjects that aren't specific to one region, but that could help NOAA. This has been, really for me, the most interesting of HSR Panel that I have, and this is my third meeting, for me, as a member of the Panel, trying to learn what we're doing, for things that are outside my wheelhouse. So I just wanted to thank you for that.

Because I think this is really something that we should replicate in the future and maybe expand a little bit.

MEMBER SAADE: So that was going to be

one of my questions is, what do we do next? So if it's okay with you, if we can continue this discussion, what do we next would be great.

VICE CHAIR MILLER: Yes. Let's, I'm just looking at time --

MEMBER GEE: We do the discussion paper now?

VICE CHAIR MILLER: Actually, let me quickly ask if there is any comments or question, public comments or questions, from the audience?

MEMBER SAADE: Dave.

VICE CHAIR MILLER: What's that?

MEMBER SAADE: Dave had one.

VICE CHAIR MILLER: And then we'll continue with what the Technology Working Group needs to do, until we break for lunch.

MEMBER SAADE: Okay.

VICE CHAIR MILLER: And anything, what I want to say is, we've got a lot to get through after lunch.

MEMBER SAADE: Right.

VICE CHAIR MILLER: And part of it is

the papers, and you have a paper to discuss. Rick Brennan has very generously volunteered to give us a precision navigation update, much like Admiral Smith gave us, on the underlap issues.

We also need to have a briefing on, just a five-minute briefing, on developments in the fleet. You know, the fleet funding.

And we've got three -- two more papers to get through. Well actually, we need to have a discussion on precision navigation, we need to have discussions on your paper and on the two that Bill and I authored. Plus, we have the letter. So, I just want everybody to be aware.

MEMBER GEE: Yes. I think for the discussion paper, we would circulate it, or you've got it, I don't think we saw that as a long discussion this afternoon.

We would, if we have time now, we'd just like to say okay here it is, and get Ed to give you the background of that and then say, okay, what should we go forward with. I think that's it for that paper, I think.

VICE CHAIR MILLER: Okay. And I think that's more appropriate this afternoon. So first of all, let me ask if there's any questions from the public, anywhere?

MR. DASLER: It's a historical comment. So Gary had a great question on, how do you validate data in hydrographic surveys.

So often times you can use, what we refer to fiducial marks, right. So there are features on the seafloor that don't change. So as you do repeat surveys or you're running crossline analysis, you can look at that repeatability.

So there are a lot of things. So when they talk about TPU, usually that's a priori, which typically is pretty broad. So we have clients that need tighter accuracies than that.

So for example, Idaho Power does a lot of work on Hells Canyon in monitoring gravel movements. So repeat surveys are key.

But you can use fiducial marks to look at the repeatability of the surveys and then even use the TPU as a scaler on that, to get a better handle on that.

So as an example of IHO special order, the best accuracy, under IHO special order, is a quarter meter. So what Carol was talking about, five centimeters or ten centimeters.

When we see, typically, you can hit six to eight centimeters when you're using fiducial marks and repeatability. But then it gets back down to, to improve that, is how are all these surveys being done, what are the models in these port surveys, to have good repeatability. Is everybody on the same page, the dredgers, the Corps, NOAA, as we're doing these precision surveys.

But yes, using features that don't change are a good method for that.

VICE CHAIR MILLER: Other comments?

MEMBER MAUNE: I have a comment, Joyce.

VICE CHAIR MILLER: Sure.

MEMBER MAUNE: When Kim mentioned that

she wasn't sure who was supposed to be part of the Technology Working Group Meeting, we have the same issue with Planning and Engagement. It's not just Joyce and me on the Planning and Engagement, everybody here is part of that.

And when we put together issue papers, that's a large topic of what we discuss, those issue papers ultimately come from everybody on the Panel. And so we like to get input from everybody, have everybody review these papers, let us know in advance, where there is room for improvement and what you think we should change in these issue papers.

So please don't think of the Planning and Engagement Working Group as consisting of Joyce and Dave, it's all of us.

VICE CHAIR MILLER: Okay, Lynne has an announcement.

MS. MERSFELDER-LEWIS: Just a comment on the Planning and Engagement Working Group and the Technology Working Group. Those emails go to everybody and invite everybody and say, in case you're interested in this presentation. So you just have to pay attention. Because they're advertised numerous times.

MEMBER HALL: And that might be the problem, there are a lot of emails.

MEMBER MAUNE: Yes.

MEMBER HALL: And so I'm going to say that, you can blame me. It's hard to keep track of what's going on sometimes because there is a copious amount that comes in to us.

And I think part of it was just, this is a great introduction because now I know and I'm going to be keyed in when those emails come in.

But I think, based on how it got started in Galveston and then in Cleveland, it seemed kind of the techy minds. Where really it was kind of more down in the weeds, not somebody like me, whose more of policy strategery --

MEMBER SAADE: We're down in the eelgrass.

MEMBER HALL: -- but it is --

PARTICIPANT: Yes, eelgrass.

MEMBER HALL: Yes, that seafloor. You guys do that.

So no, I understand that from Lynne, but there is just sometimes it's hard to navigate the proverbial HSRP waters.

VICE CHAIR MILLER: Okay, we have --

MEMBER GEE: Fifteen. Do you want us to finish off this and --

VICE CHAIR MILLER: Yes, let's finish off the discussion.

MEMBER GEE: Okay.

VICE CHAIR MILLER: In the 15 minutes we have left, let's finish off the discussion and then we'll break for lunch.

Let me just say that we're having another working lunch.

MEMBER GEE: Oh, we are?

VICE CHAIR MILLER: It will be from 12:00 to 1:30. If we have any extra time in it, we might want to have some of the working groups have an informal five to ten minute group discussion. Don't know if we have time.

And then our afternoon session, we'll reconvene at 1:30. The public is certainly welcome. I'll just warn you, it's going to be just a lot of internal, it's mostly internal, we need to get these things finalized this afternoon. So you're welcome.

I don't know, if it will be very interesting. So go ahead, Lindsay, Ed.

MEMBER GEE: Okay. So I guess just to finish off in the Working Group meetings and some of the outcomes we saw, I guess those -- I don't know if I got those separate, but future products and ECDIS was kind of connected and it was about the data infrastructure.

You know, the EC has kind of been dealt with, the D and the I and S. The D and the IS is something I think we're now really getting to. But you can't have the D without the IS, right? That's kind of the issue.

I think from the Working Group, the industry collaboration is something generally we

-- it was trying to connect. I think we see, it's not just serial here that manufacturers build something, academics are going -- the labs like CCOM develop it and then it goes out into industry.

There's a real connection that industry, and Fugro as an example, do a lot of research internally because they have a problem to solve. And I think how that gets done and how we can connect it, and the Working Group, I think, is hopefully connected at this level here. And if we can, I would encourage.

So this is really, for NOAA I guess, is like, how can you better connect with industry from a research and the transitions of technology and that emerging technology. And maybe that's through CCOM and JHC. There's a mechanism there for part of it, but I think there is other areas.

And you are making good progress, I see that with ECS and all those other things. So that was just a comment on that, finally.

Technology transfer discussion paper

I'm going to hand over to -- we've got a draft, I'm going to hand over to Ed to just give a brief summary of the background of why that was put together.

MEMBER SAADE: Okay, so we've alluded to this a couple of times and there's been some, even some testimony, to Congress. But the point of this paper was to get it across that there's a tremendous amount of technology, discovery and invention innovation that comes out of this entire hydrographic process that goes on with NOAA and the Joint Center. And all of the interaction of that, with folks in industry, with the contracting companies and companies like ours.

It turns out that there's these discoveries and these technologies are easily transferred to go out and make some money, apply it to other types of activity that has nothing to do with safe navigation and has nothing to do with charting.

So that's the intent of this paper, is

to try to emphasize the fact, outside of our little clique that recognizes this, and get the word out to the people that do spend the money in Congress and in the Senate and the Executive Branch, but also the tax payer, that there is a whole of activity going on, there's a whole lot of money being spent.

And as industry takes these discoveries and applies them, there is a whole lot of money that's being made, there's a lot of industry that's benefitting from the fact that these discoveries are really of great value.

So the main example that I'm always falling back on, or what this paper derives from, is what Larry showed earlier in the discovery of the water column detection capability of the multibeam, combined with the back scatter technology of the multibeam, combined with the basic purpose of the multibeam, which is to generate bathymetry.

When you put all those together, you can go out and apply that to -- oh, thanks for doing that. I didn't realize I had all these slides.

You can apply all that to seep detection. So seep detection isn't just for trying to do forensics on the Macondo spill in the Gulf of Mexico, seep detection now is a very normal accepted and highly utilized method of exploration for the oil and gas industry, particularly in deep water.

So as the paper goes on to describe, this includes literally tens of millions of dollars for the companies like ours, that go out and collect the data. And can be hundreds of millions of dollars to billions of dollars of revenue, relative to a -- if it leads to a discovery of an oil field. So that's a really big deal obviously.

And it all has its roots back in NOAA charting and the Joint Center in New Hampshire. But nobody talks about that. Nobody connects those dots. And that's the intent of what this paper is.

So keep all that in mind, because it's really nice, it's very obvious, it's very great that this happens, but then what do we do with that. What's going to be the pitch from what HSRP recommends, relative to this transfer of technology.

And the reality is, is with what Juliana presented and what Shep presented earlier in their presentations, when you looked at that very last slide on both of their presentations that tried to connect all the dots and how that NOAA interacts with partnerships, you can have one more column on the right-hand side that talks about the transfer of technology or the financial benefit of all the data that is accessible on the websites, that are under Juliana's control and all the websites that are under the control of the Admiral's group.

So that's another connectivity that we need to, I believe we need to get out there and emphasize, in the relevance of what's going on with everything that has to do with NOAA charting and hydrography.

So I guess that's my pitch. Is there another slide?

MEMBER GEE: Oh, no, that was it. That was just a final --

MEMBER SAADE: Right.

MEMBER GEE: But that --

MEMBER SAADE: So that's the purpose of this paper. This is the long-winded version of it.

We also scaled it back and got rid of the pretty pictures and tried to get towards that two-page typical aspect of what we're doing.

David asked me earlier in the week, is there something that comes out of all this that isn't one these technical papers and advocacy papers that we're always driving at? I feel strongly that there is and I think then that we want to throw it out to the Panel to have some opinions on that or have some feedback.

MEMBER GEE: Yes, just a comment. I think there was things to be commented with specific areas of precise navigation and recreational charting about directions and things.

I think this is one, potentially, where just endorsing something that happened, which was the Center for Coastal -- you know, the Joint Hydrographic Center and the Center for Coastal and Ocean Mapping and then endorsing it and looking at the success they've had. So I think there was some concern expressed this was restricted just to that, but that's where the example is. So, Joyce.

VICE CHAIR MILLER: I think we need to be sensitive to the fact and be aware of the, some of the original legislation for both IOCM and HSIA. Because in that original legislation -- and I am a great fan of what, or -- or JHC, or University of New Hampshire, does. There's no doubt that it's an invaluable resource. We can't estimate how invaluable it is.

But there was also- you know, and within in other papers we have called for the expansion of training, hydrographic training and so forth. So we need to be a little sensitive there, as a review Panel, of seeming to endorse that center specifically. I think --

MEMBER GEE: I don't think we're just endorsing one center, I think we're endorsing the fact of the success of that center. And, yes, there should be more. You know funding --

VICE CHAIR MILLER: Well, I mean, but --

MEMBER GEE: -- some way to do that.

VICE CHAIR MILLER: -- your first page reads like an ad for UNH, honestly.

MEMBER GEE: Well, Larry may be right.

DR. MAYER: He is right.

(Laughter.)

MEMBER SAADE: Guilty, guilty, guilt. I accept that.

VICE CHAIR MILLER: Yes.

MEMBER GEE: Yes.

VICE CHAIR MILLER: So I think the paper is too long, if we wanted to -- but one thing that we're going to consider this afternoon is, okay, are we at a point where maybe we should go back and review papers, are we at a point where perhaps instead of one-pagers maybe there's a couple of in-depth topics that we could write a white paper, a longer white paper on.

I mean, I think we're at a point where we're trying -- I'm not going to say it's a total transition, but we've now got ten papers, or, nine, ten papers, under our belt. And maybe this is -- and thanks to Scott for that vision, but this is a time to reconsider.

So I think in the framework of that, we need to look at your paper. And it's not prime time.

I think a goal, just like precision navigation, would be that for next -- for September, when we're at UNH or we're in New Hampshire, that we bring that paper also to closure. Hopefully early in the --

MEMBER GEE: So I guess what we were think of from here is, should we convert it to an issue paper that just becomes one page or should it be a longer, -- that was our question, I guess, what do you want us to do with it?

MEMBER HALL: So I don't think we ever answered the question of what these papers are for but I don't think it has to be one or the other.

I was thinking about this last night where, hey, maybe there is, with what Scott said, this is kind of a thought process of what order and where and moment in time or a length of time on a certain subject.

VICE CHAIR MILLER: Okay.

MEMBER HALL: Or maybe it is for the administrator, once we've transitioned.

VICE CHAIR MILLER: Okay.

MEMBER HALL: And I think there's got to be different products, I'm not sure we can always wedge it in to this. But that would require us to think through the processing. Using your guys' terms.

Dave is awesome at keeping us all on

track and trying to get these out, but sometimes we lose then those conversations because it's about, not the substance, but the editing and kind of knitting away details.

And so these conversations that we have, I think this paper may be a little too long, it's different. It is not the issue paper, it is kind of a broad overview.

It's our thinking on something, and I think it's a completely valid paper. And I would hate to see it get really mashed down into just an issue paper. I think it is a white paper.

And I think it's okay. I think we can expand in whatever we think it should be. And if somebody is willing to write it, that's half the battle, and we're willing to review them, then I think we're good.

VICE CHAIR MILLER: Excuse me, I missed the -- I thought I called for a public comment period at quarter till, but I didn't use those specific terms and so I need to say, are there public comments at this point? I apologize for -- on anything.

MR. DASLER: To Ed's point on seep detection, I guess everybody should be aware, so the NOAA hydrographic surveys specifications and deliverables that was just released yesterday, they now, under 1.7, under those specs, have a seep and pipeline detection report.

So often contracts, NOAA surveys, you can pick up seeps even if you're not doing water column detection, and gas is a pretty hard reflector. So those are being reported right now.

And now NOAA has a pipeline of how to get that to the navigation managers. And sometimes they're related to infrastructure that's out there and inspections are being done and if there is exposed pipelines, there's now a route for that. But I think that's a really good point.

I mean, there is this kind of information that is being provided by NOAA surveys that is going to the private sector for their use. So I think that's a great use of NOAA surveys, to support the private sector.

VICE CHAIR MILLER: Other public comments? Anything on the web?

Well, obviously we're going to continue talking about papers, or products, after. So we're going to, when we come back, I'm going to put Rick on first to talk about -- Rick, are you going to talk about the fleet issues or is someone else?

(Off microphone comment.)

VICE CHAIR MILLER: So fleet issues and he's going to give us an update on precision navigation, where NOAA stands, so that we are all on the same page. And then we will -- Bill is going to be back so he will, I assume, he'll be chairing.

MEMBER GEE: He's here.

VICE CHAIR MILLER: Oh. And then there is -- we need to consider our products from this, from this meeting, and where we go from here. So I think we can incorporate your discussion into that discussion.

MEMBER GEE: Yes, there's nothing, I think there's one more point just I'd like to raise now, is for next meeting, I think there was a brief discussion about that, and one of the things was autonomous systems.

I'm proposing that between E.J. at the lab, sorry, E.J. at the CSDL and CCOM, JHC, that they do an autonomous presentation next time. One or two, as part of the technology group.

MEMBER SAADE: Everybody okay with that?

MEMBER GEE: Or we can see an autonomous system.

MEMBER SAADE: Okay. And then we had a question about the monthly meetings. Do they need to be monthly, should they be every other month? Is anybody getting bored with them?

It's easier for us if we do them every other month, if everybody really wants to keep us driving this and make them monthly, then please let us know?

MEMBER GEE: Every other month? Every other month is fine with me.

MEMBER SAADE: Okay.

MEMBER SHINGLEDECKER: It might be nice to alternate with the P&E meetings. I find with too many meetings it's easy to say, oh, I'll catch the next one and miss it. Whereas if they're a little more special, you schedule around them.

MEMBER SAADE: Okay.

MEMBER MAUNE: Okay, that's a good point. Because our meetings don't have to be monthly either.

MEMBER SAADE: Right.

MEMBER MAUNE: We could probably do very nicely -- and I wanted to add on what Kim said. When Frank Kudrna and I came up with the idea of issue papers about two years ago, the concept was that the issue papers were to identify where there was some issue of some sort, where we thought NOAA maybe ought to do something different than what it was already doing.

So a lot of what you explained this morning on technology was, a lot of the gee whiz stuff where you're doing it great and there's not any issue there. And so, to me, you would have an issue paper, Ed, if you can pull out things that there is in fact an issue in which we would like to bring NOAA's attention to something or emphasize something or give increased funding to something where they're not already doing it.

And so if you have that kind of thing, it's an issue paper. If there's no real issue, you don't have an issue paper.

MEMBER GEE: But I think there was, I think Dr. Callender mentioned that he thought that the papers as well, if you're endorsing something that's being done, I think that's another valid thing for an issue paper to -- or some form of paper, not an issue paper, but endorse what's happening and add to that, I don't think that we should stop doing that either.

MEMBER MAUNE: Agree.

VICE CHAIR MILLER: Okay, we'll take

our lunch break now. Reconvene at 1:30 here.

(Whereupon, the above-entitled matter went off the record at 12:03 p.m. and resumed at 1:35 p.m.)

CHAIR HANSON: We're going to roll right in to the final session of HSRP meeting. I wanted to congratulate you all on your continued vigorous discussion. It's really cool to listen to. There's a lot of great ideas out there.

And I want to thank really my co-chair, Joyce Miller, for taking the reins, and doing very well. So, thank you for that.

I think we have a little bit of a challenge this afternoon, based on the rigorous discussion, robust discussion we've had. Because we've got a lot of work to do, got a lot of places to get to, to draw this thing to something we can work with going forward.

We've got challenges that we got from Dr. Callender and Rear Admiral Smith, and recommendations. We're going to have to figure out what we want to tackle, what we think is appropriate for us to deal with and encourage.

We've got issue papers that are outstanding, have been for awhile. And what I'd like to do with those is make sure that we stay focused on them. And if we decide we're just not going to get there with them, let's go ahead and move on. We got plenty of other things to talk about.

We have to decide on new issue papers. And then we have to also discuss, do we want to continue with issue papers moving forward, or do we want to try a different approach in addressing issues that maybe are just of interest to us, versus things we actually need to produce a product.

And then finally, the big thing we're supposed to be doing is drafting a Recommendation Letter. So, I think we've got some ideas on what might be in that. We won't get to a final conclusion, it will be a draft. But what I would like to do is to make sure that we discuss the points that we want to cover. And then we'll share the draft for whatever we want to do after the fact.

(Off microphone comments.)

CHAIR HANSON: All right. Let me conclude here, and I'll turn it over to you, sir. As I said, I want to make sure that we stay focused. We like the discussion. We need that. That's what makes this Panel work so well. But we also need the movement.

Just a couple of seconds about where I was for the last 24 hours. And that's with another advisory group that I'm part of. It's called Supply Chain Competitiveness. And it's actually out of Department of Commerce.

And basically what it is, it's the big supply chain folks involved with driving America's economy. Everything from Boeing, to Lowe's, and Campbell's Soup, and all the guys whose products really make us great.

And in talking about issues of rail, highway, air, and water, my favorite story with these guys is, I first started asking them early on, so, what do you guys prefer, air, water, highways, or rail? And their answer is, yes.

So, but it kind of, you kind of think about it, and that's the right answer, right? Because the investment in one mode drives innovation. It's what drives change. It's what drives investment. So, you really do need to look at all the various things.

And certainly, I don't get to talk about dredging much more. Because after awhile they just talk about ports, and vital, vibrant seaports as being part of the discussion. And so, that's good.

And the reason I mention some of this is that one of the things that we've learned over the last few months, and well, few years, is that when it comes to the things that we're talking about here, as well as they're talking about there is, if we sit there and the first thing out of our mouth is, we need more money, we kind of lost the whole audience.

Because everybody in the room is

asking for more money. And the supply chain guys, like I always talk about, there's not a customer in the world that wants to pay more.

So, what they're focused on is finding new innovations, new technologies, new methods of doing business that will allow them to compete with each other, not raise costs. Because it's just not going to happen.

The meeting was actually at the Boeing facility and, which is really impressive. If you ever get a chance to go up there they have a flight museum.

But the lead from Boeing talked about being able to fly from Seattle to Los Angeles to go to Disney World with his family over the last 25 years, all for $200 dollars. It was $200 dollars 25 years ago, it's $200 dollars today. And that's because they're able to drive innovation and supply chain discussions to innovate.

So, the message here, and something I'd like to have us focus on as we get through our other duties is to focus us on the challenges for charting. Focus on the innovation. We had some great Panels, and almost every one of them talked about doing things differently, doing things a new way.

And what that's going to do is, if there is no more money for projects, no more new money for surveys, then what are we going to do to innovate, come up with getting the data in different ways? And that's all we've been talking about.

And so, I think we've got some answers. We've got some solutions to offer. And I'd like for us to focus on that for the rest of the afternoon as we go through these other issues.

And we're going to start off with Captain Brennan. And then I'm going to turn it over to Ed and Lindsay to talk about tech transfer as well. So, Captain Brennan.

CAPT. BRENNAN: Okay. So, this was, after the discussion about the precision navigation it was clear that we probably just need to give a State of the Union on where that effort sits.

Because it's been, you know, I think the data was actually acquired in end of 2012, 2013. And so, we've been managing this. Admiral Glang had committed to keeping this project active for five years.

So we're, you know, I think in at least year two or three of that project right now. So, just as some background, the channel depth going into LA Long Beach was 76 feet. The ships were loading to 69 feet.

And they had a particularly bad winter storm. And one of the pilots noticed that the ship, these ultra large crude carriers, 1,000 feet long, were moving around a lot more than they had, you know, than they kind of had anticipated.

And somebody did the, you know, the cocktail napkin sketch and said, well, if I have a 1,000 foot lever arm, and I deflect it by one degree, what does that look like? And that, you know, that deflection at the bow ended up being, you know, 10.8 to 11 feet.

And they realized that, well, if our draft is 69 feet, and you add ten feet to that, geez, doesn't that exceed the channel depth? And I -- and so, they, the Captain of the Port immediately pulled the maximum draft back to 65 feet.

And that's when the Jacobson pilots in the port of Long Beach started to embark on this under keel clearance system prototype that they've done. And so, that was a joint effort between the port and various parts of NOAA, and IOOS, and SCRIPPS.

And so, it was, I think it's been fairly successful. And we most, just recently got word that the Captain of the Port is increasing that depth from 65 feet back to 66, which is an incremental and a phased approach, which I think is what they had announced when they did that.

But just that one foot of draft, I mean, I think we saw stats on that for corn, and wheat, and soybean yesterday. And the highest was soybeans, which was I think just about a million dollars for a foot of draft.

But for one of these vessels a foot of draft is 40,000 barrels of crude at 50 dollars a barrel, is 2 million dollars. So, that's an additional 2 million that that program has yielded to bring those ships in, which I think is a pretty exciting number.

Can you switch to the next slide? I don't have the clicker. So, this was the survey area that we had. We split that up into small cells. And so, we've been providing products to the pilots there, you know, since I want to say early in 2014.

And so, originally the pilots were using a portable pilot unit called PilotMate that was created by Booz Allen Hamilton. It was, at the time was fairly old technology. And it was -- we found out shortly after all this that Booz

Allen was going to stop supporting that particular unit.

And so, while that was still in use they were -- they had asked for us to give them data from this project area. And, you know, this is kind of the typical thing for a hydrographer. They say, you know, how much do you want? And they said, well, we want all of it.

And so, we said, right on, here it comes. And I think we even had decimated it down to a five meter bin, just to not give it to them at full resolution, and sent that off.

And they, we, you know, followed up with them a couple of weeks later. And they said, well, funny, you know, our boat stops moving when we bring this data up. And it was because it was, just completely bogged the system down. Because ultimately what they were trying to do was a poor man's DTM on this, where they would color code all depths shoaler than the draft. And so, they literally just were doing it on a, sort of this binary basis. And it computationally was not very efficient.

So, we've been going through a number of iterations with them. And so, after that we said, well, how about we try giving you contours. So, we gave them some high resolution contours that looked like this, and some soundings. And with it, and provided that in an S-57 format.

And they sort of liked that. And so they, then they agreed that they just would take contours. And they seemed to be happy with that. And now we're actually providing them not just contours, which is not a, it's just a polyline. We're actually providing them depth areas, which is wonky S-57 terminology for an area versus a line feature.

But the beauty of that is that they can tell where they're at in that area, and that they're within an area that is of a certain depth range. And so, it has that value to them on that.

And so far they've been pleased with that. They just recently signed an agreement with CIQ, this is Long Beach, to make CIQ their portable pilot unit of choice. And interestingly, LA went with a different one, just because their brother went with CIQ, and went with the Trelleborg one.

But luckily both of them take this BI ENC data format. And certainly we've had good relationships with those guys to test these various data types out, and see.

And so, we're just starting to get, now that the pilots have this, we're starting to get some feedback on that, which is really the, has been the intent of this whole project all along, is to try and get feedback on, you know, like I said, the eye test. Does this look good? Or does that look better on it?

MEMBER GEE: Do the new systems take the grid too now?

CAPT. BRENNAN: So, CIQ does not right now, I don't believe, but I think ultimately what we're hearing is like, well, sure, if you come up with a standard, and you're going to provide it everywhere, we'll write some software to read it.

But particularly CIQ has been, at least to date right now, has been less receptive about doing that unless we're going to fund that development with them. And that's not out of the question at this point. But at this point we've been trying to do that in partnership.

So, flash forward to the Puget Sound area. That yellow box defines nominally the area that we have for the bathy database project here. And so, the intent here is to kind of take the Port of Long Beach project, and step it up to the next biggest scale. And see what are the scaling problems that we have.

So, Port of Long Beach is a nice little postage stamp of data theoretically, or in size. And then you look at this. This is a much more regional scale. So, we're trying to understand, what are the issues as you step that up?

And so, as you go back, and you look at this, particularly the issue that we have here is that the raw contours that get created, or depth areas, because ultimately that's, you have to start with the contour to get to the depth area.

They're highly figured, and highly detailed. And from a navigational standpoint they can be kind of confusing. So, one of the things that we're looking at, I'm going to go all over the board here.

But so, you can see this is what you get sort of as a raw output. And there's a lot of isolated -- I guess I don't, just killed it. So, the problem is that you have lots of areas that are isolated, contours that can be confusing I think cartographically.

So, one of the things that we've been looking at is some different algorithms to do that generalization, and do it automatically. And so, we've been working with a company in the very early stages called SCALGO, from Denmark.

We've also done some testing with Seven Seas software, to see how we can create multiple scales. And the scale bands that you see here are the scale bands that are being defined for the New National Charting Plan.

And so we would, we can automatically extract those contours, and have them generalized for each of those different scale bands, and provide those automatically and, you know, in the software, which is where we want to go.

Because when you start doing this on a larger scale human intervention is something that you have to keep to an absolute minimum. So, that's been the intent on this.

So, we've had really good results with this. And the beauty of this software, and what the Danes have done with this is actually, you know, the sounding, the contour selection is done first. And then the soundings are selected in harmony with those contours.

And that's always been the most manual part of our chart compilation, is ensuring that you don't pick a sounding that violates that generalized contour.

And so it's, I know that's really, probably esoteric, geekyland stuff. But it takes a lot of time to do that. So, this software has actually, they've actually put a lot of thought and effort into generalizing contours, so that they're navigationally correct, and then selecting the soundings, so that they indeed honor those contours.

So, that's a huge step forward. And if we can automate that, that would be a major step forward for us. Not only just doing that automation, but doing it through a half a dozen scale bands at the same time is really exciting. So, we're intrigued by that.

So, that's where we sit right now. Going back to the port, the Puget Sound area here, we've got a, this is from a paper that Katrina Wiley presented at the Hydro Conference.

So, we've been looking at the rules to take that, once you assemble that bathy database, what are the combination rules that you do? Because we're going to have multiple surveys from multiple vintages, from multiple agencies that may come from, some of it may be crowdsourced, some of it may be Corps of Engineers, some of it may be university. Who knows?

But can algorithmically combine that in the most logical and navigationally correct manner, so that you can then generate product from that.

So, once we assemble that grid, and we say that, okay, we think that the combined rules are correct, and the grid is solid, we would then go and run through a comparison algorithm, that would then compare the model against the currently charted soundings, just to confirm that there's nothing in the model that violates what's currently charted.

And if it does, we would have a, you know, a feedback loop that would have us go in and check that, and see, you know, is it shoaler? If so, then what is it? Does it, you know, does it beat what's on the chart? Or if it's deeper, does it not?

So, we're currently working through that right now. And we're hoping to have some test products for here in Puget Sound by the end of this calendar year, to provide to the mapping and charting division for review and analysis.

So, that's, I think from the precision navigation standpoint, and where we are with that in being able to provide products, that's --

One other thing, I guess back to Long Beach. I think the, one of the encouraging things that we've had there is that since setting this up we've gotten a number of surveys in from the Corps and from the port.

And this is the intuitive, this is what we've intuitively known. But I think the data has shown this, is that when we get new data we can very easily drop it into the grid, analyze it to see if it's, you know, from a QC standpoint, to see is it in harmony, or does it, you know, really violate what was, what we already knew about that? Make that analysis, and then quickly create new products for that.

And we've been able to do that in about 24 hours, turning that around from the time we receive the survey, getting it in, and cutting new contours and soundings from that.

So, a significant reason to be encouraged by that. And so, that's why we're pushing forward with Puget Sound, is to take that to the next largest level, and see how we manage a bathymetric database at that size. So, if there's no questions, I'll continue.

MEMBER MAUNE: I have a question.

CAPT. BRENNAN: Yes, sir.

MEMBER MAUNE: Are you using one meter contour interval?

CAPT. BRENNAN: We've used a couple of different ones. That was why I'd asked Sal that question yesterday. Because that's been the question as to what is it?

And so, you know, is it ten centimeters down to 20 meters? Is it one meter down to 30? Is it 50 centimeters? So, that's been the question of what's good enough. And so, we haven't settled on that yet, because we're not producing products for public consumption just yet.

I believe in Long Beach what we're producing is every 50 centimeters. So, it's higher than one meter resolution, or one meter contour interval.

So, for Long Beach it's every 50 centimeters. So, we have a contour at one meter, one and a half, two, two and a half, three, three and a half.

MEMBER RASSELLO: That's excellent. But I have a couple of question on the scaling. Can you go back to the, okay. This is the same port area, right? So, I think already this establish the scaling brackets where ports shall display, right?

CAPT. BRENNAN: Yes.

MEMBER RASSELLO: So, I think it's around 1:15,000 for port area?

CAPT. BRENNAN: Yes.

MEMBER RASSELLO: Then as you

approach, goes 1:25,000 I think, and go to 1:140,000 on the coastal water. The ECDIS already does this job to select which contour do you need, according to the size of your ship.

CAPT. BRENNAN: If you have it in the data it does that.

MEMBER RASSELLO: Yes. You got to have the data on the net, right? So, the first picture, where all that line was so cluttered. Then, with the ECDIS you define which corridor you need, according to your draft, plus the underkeel clearance?

CAPT. BRENNAN: Yes.

MEMBER RASSELLO: That's already something that the system does automatically, that's what we do every day. We set up what we need under the keel. And then we got the corridor, if there's any corridor.

CAPT. BRENNAN: But if you look at this, this is what I was --

MEMBER RASSELLO: I try not, the question was, why do you need all this scaling of the same area?

CAPT. BRENNAN: The ECDIS doesn't do the generalization. So, ultimately what we're trying to get to is the ability for a user to zoom in and out through, at any point in the area that they're interested in, and get scale appropriate data as they zoom in or out.

And so, that's ultimately what you are able to do in Google Maps now, anywhere in the world. We want to be able to do that with our bathymetric data. So, but you have to --

MEMBER RASSELLO: It's a plus I think. But is really needed to do that? I'm talking for safe navigation. I'm not talking, if you want to talk about to see exactly on that spot how much water do you have.

But for me, I just need to select my corridor. So, I need the safety contour. And when I start the safety contour on 11 meters, and I set my safety depth on 11 meters it comes one, two colors.

CAPT. BRENNAN: Yes.

MEMBER RASSELLO: Go or no go.

CAPT. BRENNAN: Yes.

MEMBER RASSELLO: That's it.

CAPT. BRENNAN: And so, that's absolutely what we want to do. But we're, what we're trying to get to is ensuring that the ENC that we provide you has the data to support that. And so --

MEMBER RASSELLO: The ENC must have the data. But we don't want to see all the cluttering on the screen. Just safe or not safe.

CAPT. BRENNAN: Yes. Absolutely. Well, and that's where the ECDIS steps in and takes over. And it handles the display on that. But this is really, what do we put in the data bag, the data container, not bag, but the data container that holds the, that holds all of that.

MEMBER RASSELLO: So, that's why you need to follow the ECDIS standards. Otherwise they would not be able to be read on the ECDIS monitor, this product.

CAPT. BRENNAN: And this is following

the S-57 standards right now. And, but how that's displayed in S-52 is controlled by that system.

So, I think we're in violent agreement on that. You know, and so, but the question is what are, what is that interval? Do we need soundings? How do you want to support it at higher scales?

I mean, this is one thing for a port. But if you were in the middle of Puget Sound, for instance, you know, you may need to, you know, you may need to be at a, you may not need to be at 1:5,000, or even 1:12,000. You may be at 1:80 or 1:40.

MEMBER RASSELLO: Yes. I --

CAPT. BRENNAN: So, we want to be able to at least have that ability to support that data at that zoom level. And that's the thing. So, there's a number of really esoteric technical discussions here about how to, how do we put that data in?

You know, are they managed on a tile

by tile basis? Is it managed by applying different scamin, scamax values? I mean, this gets into the wonky attribution land of S-57. And I was told I wasn't going to go there. So, I'm not going there.

MEMBER GEE: Just a comment. I think it's interesting that, Sal is a user. He's commenting on what he needs. And he doesn't really actually need to know what you're doing underneath the hood. But as long as you meet with the compliance.

CAPT. BRENNAN: Exactly.

MEMBER GEE: And I think that's actually satisfying. What I'm interested to know is, going from the original question asked about the grid.

It seems you have to, if it's algorithmically able to generalize that to produce those, the next step could be, if that's algorithmic, working with the ECDIS and the contour I think would actually give them the underlying thing. And they include those algorithms in there. So, it is that dynamic Google. I think that's probably the future. I --

CAPT. BRENNAN: Right. You won't get any argument from this side.

MEMBER GEE: Right.

CAPT. BRENNAN: Now, internationally that's a different story. And people, that's a, today that's a bridge too far for many people, is to turn that cartographic responsibility over --

MEMBER GEE: Oh, true.

CAPT. BRENNAN: -- to the ECDIS system.

MEMBER GEE: But that is the future.

CAPT. BRENNAN: Oh, absolutely.

(Simultaneous speaking)

CAPT. BRENNAN: I 100 percent agree.

MEMBER RASSELLO: I don't believe that the precise navigation does not really apply to large vessel. I think depending on what safety contour you want on the ENC, a sailing boat with five feet of draft, they still need the safety contour of seven feet, or eight feet.

So, that's what I think when we talk about precise navigation, we should not restrain to large vessel. I think it applies in every single aspect of the navigation, with the safe navigation.

CHAIR HANSON: Thank you, Captain Brennan.

CAPT. BRENNAN: I'm ready.

CHAIR HANSON: Go ahead.

CAPT. BRENNAN: So, I don't have slides for the fleet update. I'll keep that hopefully even more brief. But I think just as a recap, Admiral Score had commissioned an independent review team of industry experts, of which Dr. John Hughes Clark from UNH was one of those.

And we had people from industry, from, I'm trying to think of, it was the ship building sector from other military and government organizations, et cetera.

And they had produced their report.

And simultaneously, or concurrent with that there was also a Tiger Team that was set up of NOAA stakeholders that worked on coming up with a new fleet recapitalization plan. And that was running through last summer.

And that plan was released and accepted for public distribution in October. And since we were able to get that plan out, Congress did disburse the first $80 million to OMAO for the ship building program.

So, that came in, and that, so OMAO is quickly, had to turn around and provide a spend plan for how they were going to do that. That's, that has been released as well.

And, but I think that the challenges that we have currently are the fact that in order to procure a ship, you can't come in with only 50 percent down. You need to be able to put 100 percent of the funding to purchase that.

So, at this point we can't put any money down to buy a new ship, or to, you know, to set that contract in play, until we get the second installment of that.

And so, given the new administration there's certainly concern that half of a ship is as good as none of a ship. And that $80 million could be taken back. So, at this point there's a lot of uncertainty.

We're hopeful that, you know, there's been some language that has seemed to indicate that ships are still, you know, a good thing for NOAA. But at this point it's unclear how that's going.

So, we're proceeding full speed ahead on that. Right now in reestablishing the ship building program within NOAA that had been, since it had been unfunded, it was down to pretty much a skeleton crew. So, they're working on hiring back that team to do that now.

And working with NAVSEA to establish the necessary MOUs, et cetera, to do that. But even NAVSEA was, you know, until we actually had the funding in hand, was not prepared to begin communications with us.

So, all of that is currently underway. So, there is a sense of cautious optimism with that. There are a number of other elements that are underway right now as well to support the fleet.

One of those is a force architecture study. And so OMAO has hired a consultant to come in and develop a force architecture model. And they've been using the NOSIA model at NOAA to identify all the requirements, and identify what the top tier of requirements are, so that they know how to, you know, what the mix and the shape of the fleet should look like in the future.

And so, certainly we're excited to see that nautical charting and ocean mapping came out on the top of that list. So, that was, as far as fleet purpose goes, that was the, what was deemed to be one of the highest priorities.

Because it was a cross discipline service that all the offices, even our counterparts at Fisheries recognized that being able to do ocean mapping was critical even to their program. So, we were cautiously optimistic of that. So, I'm not sure if that answers all the questions. But I'll take any that I missed.

CHAIR HANSON: All right. Anne and Lizzie, I understand that you've already been given your time. So, just kidding.

But I do want to point out that I was struck by one of your last points about, talking about return on investment, and making the case. Because that is the talk.

And it's how you win the innovation dollars, you win the investment dollars, is by showing that direct correlation in the current environment. So appreciate that point. All right. Joyce and Dave, ready to get into the issue papers?

MEMBER MAUNE: Yes. I think Joyce is going to take over. These two papers were authored by her and you, Bill. So --

VICE CHAIR MILLER: Okay. So, let me just recap. The precision navigation paper is on hold. And we did get the figure we wanted from

Susan on the recreational boating. And she is going to incorporate any comments that were made and go there.

I'm going to repeat a little background on the two papers that Bill and I authored. They started out as one. Incorporating issues on what we heard from Admiral Smith the first afternoon, about differences in the data produced for channel and harbor charting between the Army Corps and NOAA.

And that original paper started out also incorporating issues about external data, that external, I mean, what I mean by that is not NOAA and not Army Corps.

So, people who might, or groups who might not know what a proper hydrographic charting is. But the issue started out as, how does NOAA deal with everybody else's data? That was really kind of our starting point.

And in conversations with Admiral Smith we decided we had two long, probably a total of three hours I think, conversations with

Shep. And I think all of our thinking, and all three of us, our thinking evolved in that.

And that's when we eventually decided to go back, or to take those two topics and separate them. So, that's the two papers that we're discussing. Let me get my drafts here.

And we've had, we certainly have had many realms of comments on these during our P&E meetings. So, the first paper is titled "Surveying and Charting in Channels and Harbors." There was a recent comment on it.

Okay. And the second paper is titled, I'm having trouble getting to it here.

MEMBER MAUNE: "Improving Data Access for US Nautical Charts Using Multiple Data Sources to Produce More Accurate and Detailed Charts."

VICE CHAIR MILLER: Yes.

MEMBER MAUNE: Last updated February 11th.

VICE CHAIR MILLER: Okay. That paper had, as far as I can see, no outstanding comments. Whereas, the surveying and charting in channels and harbors did have a comment from, one minor comment from Lindsay.

Admiral Smith, if you have those papers in front of you, the recommendations are not identical. But they aren't dissimilar. I mean, basically from two different audiences, if you will.

And the recommendations included formation of an independent review team to review the process by which non-NOAA data are elevated and used in nautical charts. Making clear both internally and externally what data are currently used for construction of charts in our federally maintained harbors and channels.

Implementation of national standards for surveying and charting of harbors and channels that are consistent with international standards. Establish a metric to survey all federally maintained harbors and channels, with both full seafloor coverage and object detection at a prescribed interval, example, five years, or three years, or whatever.

Establish consistent data exchange in posting between NOAA and US Army Corps of Engineers, preferably on a single, central website.

Two of those recommendations are identical in the data paper. The formation of an independent review team, and making all the data available.

And I would also note that in the recreational boating paper we make the identical recommendation of making data available and easy to access.

Now, something came in on this, during this, the discussions. Jeff, our speaker, yesterday afternoon was it, suggested that NOAA revisit the NRC 1994 document. And that recommendation is not dissimilar from our independent review team.

But in discussing it a bit before Shep left, he said he doesn't want, you know, recommendations to have two independent review teams running at the same time. And at lunch Dave Maune had some possible ideas of other ways to get independent review.

The idea there is that there's a lot of kinds of data out there. And if two federal agencies cannot agree on what the proper standards are, then the independent review team, like we had with the fleet, makes a certain amount of sense to, if there are conflicts in what the standard should be, that you bring in outside experts and try to make those decisions. Or try to make recommendations at least.

So, Shep asked that we modify that first recommendation about an independent review team. And I would like to open that up for discussion.

MEMBER BRIGHAM: Yes. I mean, I think that the National Academy and the National Research Council is the way to go. I don't think it should be interagency, and not the stakeholders.

The most authoritative studies done in

this country are done by NRC. In fact, that '94 study. That's what the nation needs. Coast Guard needs to be a player with NOAA. My God, the Corps of Engineers probably needs to be part of this thing too, right? Producing charts, so to speak.

VICE CHAIR MILLER: Yes.

MEMBER BRIGHAM: So, I really urge, it costs money, interagency. It shouldn't be just paid for by NOAA. It should be paid for by multiple agencies of the government. But independent, I detect means interagency. And I don't think that gets to the stakeholders.

VICE CHAIR MILLER: Dave, did you have some suggestions on --

MEMBER MAUNE: Well, my comment had to do with the fact that I usually map the land areas of the United States. And when it comes to digital ortho photos we have the National Digital Orthophoto Program, NDOP. For elevation data we had the National Digital Elevation Program, which has now become the 3-D Elevation Program.

And each of those programs, the various stakeholders involved get together. And they resolve policy issues among them, and technical issues among them. And I was involved in a number of those NDEP activities.

And now that we are getting into something called the 3-D Nation. I don't know if you know what the 3-D Nation is. But it's a concept endorsed by NOAA, Corps of Engineers, USGS, to acquire accurate, consistent, seamless elevation data from the tops of the mountains to the depths of the ocean, to include inland bathymetry, near shore bathymetry, deep ocean bathymetry.

And we may have a need for a 3-D Nation kind of equivalent to the 3-DEP, in which the various agencies involved in producing 3-D Nation datasets get together to resolve policy issues and technical issues.

And come up with standards, guidelines, and that sort of thing on what they will do, so they all operate with consistent standards, and have a consistent goal, so that we can have seamless, consistent, high accuracy, high resolution elevation data from the tops of the mountains to the depths of the ocean.

And so, if we could have something similar for the 3-D Nation that we now have for 3-DEP for the land areas, I thought that might be something we would consider.

MEMBER BRIGHAM: As long as, whatever the study is, futuristic and strategic, I don't think you're going to get that just from the government, to be frank. I think you need to go whoever the nation's experts are outside, under the Academy, and harness some vision on this stuff.

Yes, I agree with you. It probably should be 3-D vision. But I just don't think it, just disagree. I don't think it come from government. I think it needs to be a true external, authoritative review, analogous to that '94 study, which was pretty influential and pioneering and authoritative.

CAPT. BRENNAN: So, if I could just, I guess pile on with what Dave said. There is a, so Dewberry had conducted the study for the 3-DEP program. And it was, I haven't read the entire study, because it's quite voluminous.

But among other things, it was an economic analysis as well, as far as the economic benefits. But it did get into the technical aspects of it.

We have just completed the scoping study for the, you know, for the water portion of that, or the ocean portion of that. So, that is underway. And that is, you know, it is being done by a third party.

And so, I think certainly having that, whether it's done simultaneously or in serial fashion, I think that that's going to be a critical one. Because it does take into account all the major federal and state agencies that would be relying on that. And so, I don't know. Maybe Dave, if you can speak to what the --

MEMBER MAUNE: As well as nongovernmental organizations.

CAPT. BRENNAN: Yes.

MEMBER MAUNE: Private industry, the universities, Nature Conservancy, those kind of guys. Not just federal government or state government, but lots about everybody.

CAPT. BRENNAN: But I, and I think one of the interests was to get through to coming up with, can we agree on a common standard? Is that safe to say?

VICE CHAIR MILLER: That was certainly my intent in starting those, or in writing that.

CAPT. BRENNAN: No, but with the, in the NEEA study with its, the expansion of that NEEA study. So, I'm looking particularly at Dave, since he's been, he's worked on that uniquely. So --

MEMBER MAUNE: Well, the NEEA study did not set out to establish common standards. But that's what happened as a result. They saw the benefits of having standard products for common uses.

And the national standard is now QL2 LIDAR for the land areas. And will we have something, standard bathy products, or bathy LIDAR, and for sonar, for example, remains to be seen.

MEMBER SAADE: I'll go first. So, we lived this whole thing off the State of California in the mid 2000s. And it took us about four to five years to get a consensus with everybody that Dave had mentioned, university, NOAA, the Navy, various researchers, you name it.

We, as representatives of industry we kept advocating collect the data to NOAA standards, NOAA charting standards. And that's indeed what we wound up doing with LIDAR, with acoustic systems.

The entire dataset was set up to be collected at NOAA standards. And that proved to be a really great way to do it. So, I don't know why we'd ever change from that.

VICE CHAIR MILLER: Larry, do you have a comment?

DR. MAYER: I was just looking for clarification. Because I think we have some cross discussion in terms of this idea of an independent review. As I see on the document we're talking about, surveying the charting channels and harbors --

VICE CHAIR MILLER: Yes.

DR. MAYER: There's a recommendation for an independent review team to review the process by which non-NOAA data are evaluated and used in nautical charts. There's a very similar recommendation on improving data access. That --

VICE CHAIR MILLER: Yes. That's, it's essentially --

DR. MAYER: The standards.

VICE CHAIR MILLER: It's almost identical.

DR. MAYER: But we also had the discussion on Tuesday of a new study of the NRC report, which was really "Charting the Course into the Digital Era." That was really a more charting focus, what the Chart of the Future should look like.

And now, it is certainly conceivable that a single NRC study, no, I should say, there is no more NRC. It's the National Academy now. Could do both. You defined the statement of the task. But I was just worried that the conversation here was going in two different directions at once.

MEMBER GEE: Yes. But I would comment on that too. The problem is, if you take all of those things and add them together, it gets so large that it could just take too long.

Whereas this, the first one about the surveying and charting seems quite specific. And how do you, I guess you can set phases in your, the way you set up that study.

But my other comment regarding that was that just from the bottom up, I think I mentioned it before, is that I, when I was reading this, and when we talked about independent review it was, the projects are so siloed right now, I think the reason for suggesting the review when we were discussing it was to try and bring those together.

And as I mentioned before, I think we got to start. Somewhere in that we got to have the message that, you know, the construction project, whether it's dredging, whatever it is, is not done until it's charted, right? It becomes part of the project.

And I don't know how we put that in. But it, otherwise we stay in those silos. And it's going to be, hey, I'm done. Now I'll hand it over, and then we'll come back.

So, from the point of view of how we present that, it's like, it's a project. They are little projects, or big projects. But they're not done until it's charted. So, hey, you include that in. And that was one of the backgrounds why we thought it needed multiple input into that, I think.

MEMBER BRIGHAM: Just to add an aside, we had some discussion yesterday when you had the Coast Guard doing the ECDIS stuff, and setting all the standards. And I'm not sure there's unity or stakeholder input, cross functional kind of relationships with NOAA on that particular topic.

I mean, there are meetings and stuff. But whether, well anyway, different agencies doing different things, different standards. And we all have to kind of move the standards at IMO and IHO kind of together.

VICE CHAIR MILLER: Bill.

CHAIR HANSON: Yes. Just a couple of thoughts. First off, Lindsay's point about, well from the dredges perspective, where our project is not done until it's charted and surveyed. That's when the dredge is released. And then we move on to the next project hopefully.

MEMBER GEE: But I mean, I don't mean charted by the dredges. I mean, charted.

CHAIR HANSON: Right. Right. Exactly.

MEMBER GEE: Yes. For that.

CHAIR HANSON: So, that's a point.

Some of the conversation it was also clarifying some of the understandings about what happens on a Corps project.

MEMBER GEE: Right.

CHAIR HANSON: Particularly, there's a different multi-beam survey on every new work project. And maintenance is single beam by Corps' choice, because they monitor the thing.

So, I think a lot of the discussion is, how do we use that single beam data? How do you make that data usable?

MEMBER GEE: That's what I said.

CHAIR HANSON: If at all possible.

MEMBER GEE: Sorry. But what I mean is by including that in the -- That kind of discussion about single beam or, that goes away if you start talking about it as the final charted product. Because NOAA already have the regulations and responsibility for producing that product. So, if it's not available in the correct format, well, we can't chart it properly. So, the project's not done.

It was trying to use that approach to get around the, oh yes, well, this is a single beam, and it's not object detection, and those sort of things.

CHAIR HANSON: Got you.

MEMBER GEE: It's kind of bring those together so that it is understood that that's what we're trying to achieve.

CHAIR HANSON: Yes.

MEMBER GEE: Because that, and that was the discussion that the independent reviewers had. Okay, can we get people to understand that, and move it forward?

CHAIR HANSON: Right. Agreed. The other thought is, who does the review? Part of the process is finding somebody who can respond quickly.

If it's not done to NOAA's standards, is it automatically eliminated? Or is it NRC, is it 3-D, is it an ombudsman? Who's got the ability to respond quickly to make a decision yea or nay? Because we don't sit around five years waiting for a decision, right?

MEMBER SAADE: So, in the California state model it was a committee that was set up, which was partially academic, partially industry, and partially state government.

But the insistence on collecting the data to the NOAA standards, it made sure that it was of the highest quality. And that satisfied MBARI, and it satisfied the Ocean Conservancy, and these other people that were looking in.

But it also took care of the fact that if you collect it to NOAA standards it automatically can be chart worthy. And if you can make it chart worthy, then you can, it's easily Fisheries Habitat worthy, it's easily aggregate zones, surfers, whatever folks who want to use it, expiration people, everybody along. Everything can cascade down from that standard.

VICE CHAIR MILLER: And part of the kind of logic in making a suggestion like this is, we as a Panel can only recommend, make recommendations to the NOAA Administrator. And so, that's the reason this reads, let's see which one it was.

Right. But in the beginning we said NOAA should work with other partners and agencies too. And that was, you know, because we, I find it a little strange that there we're the Hydrographic Review Panel, but we're a NOAA Panel.

And everything else is, you know, that's not, because the Army Corps does hydrography too, you know. And so, there's nobody there to say.

And so, I think maybe what we could do is say, a review, an independent review team, such as the NRC. Or, you know, with a suggestion, but not a specific entity that makes this. I don't know. I'm kind of struggling for how we would --

DR. MAYER: It's very simple. The next Ocean Studies Board meeting is next week. That's why this is so timely. Because all I need to do is suggest to them that this be a potential study area.

We'll take over. We'll contact Rick or Shep. We'll contact somebody at NOAA. They'll contact, if we recommend that there should be an interagency, and I agree with Lawson, it's the way you get it affordable.

Contact somebody at the Army Corps of Engineers. Contact somebody at, who else would be potential, the Navy, Coast Guard, you know. So, four agencies. You split it among four agencies, that's $50,000 an agency. That's affordable. Something like that.

And then they'll probably also contact the Marine Studies Board. There's another Board that has jurisdiction over this area. And so, it will be sponsored by the two Boards.

And what will, the only thing that we would need to do potentially, and that's up to the agencies themselves, is there will be, the academies will look to the sponsoring agencies for a draft statement of task. What do you want out of that review?

And so, whether that would come from, initiated from this committee, and it might, because you started it. At the end of the day it will go up through NOAA and the other agencies. And they'll negotiate with the academies what the statement of task is.

VICE CHAIR MILLER: So you, do you think this as it reads, maybe take off the caps from independent review team, and just make it a generic?

DR. MAYER: I mean, I, you know, the academies are always looking for studies to do.

VICE CHAIR MILLER: Oh, okay.

DR. MAYER: So, all I got to do is suggest it, and they'll take the ball and run with it. But I don't want to suggest it unless it's the consensus of the group here.

VICE CHAIR MILLER: And the --

MEMBER HALL: Maybe the, oh, sorry. Maybe the fix is just not getting team out of there, and that they conduct an independent review.

VICE CHAIR MILLER: Oh. Andy.

MR. ARMSTRONG: Yes. Perhaps I'm overly bureaucratic here, and cautious. But sort of sending out a statement at this point asking for a review, and get the Ocean Studies Board in there, it seems to me is fraught with potential trouble.

We, I think we ought to have a little more time to think about this, craft what, how we would like this done, do some consultations around the agency. Because the agency will be the one who they come to and ask for the task.

Maybe I'm overcautious. But it seems a little precipitous at this point to me, without some more discussions, to be firing off a request asking for a review.

MEMBER LOCKHART: Can I, I'd like to follow-up on that. I actually agree with you, Andy. I think that what we've seen here with Shep's response the other day is that there is some movement being made here.

And I think if we go ahead and charge

ahead with recommending an independent review at this point we may undo some of that work that's already happening.

So, I think we, if there's something already happening to improve upon this area, I don't think we want to step inside of that right now. I think we need to give it time to see if --

VICE CHAIR MILLER: I actually --

MEMBER LOCKHART: -- it's going to take care of itself.

VICE CHAIR MILLER: I mean, Shep did say that it doesn't hurt to have something like this in his pocket.

CHAIR HANSON: Yes.

VICE CHAIR MILLER: And so, and, I mean, Bill and I really covered the bases with Shep. There has been a lot of discussion.

MEMBER LOCKHART: I'm not saying don't submit the paper. I'm just saying, do we really want to insist on an independent review? I think the ideas in the paper, this is still an area of concern. And I think we all agree with that.

But is the recommendation for an independent review, or do we just maintain the other recommendations, and bring the issue to light?

VICE CHAIR MILLER: Ed.

MEMBER KELLY: Joyce, I think we can't be overly prescriptive on how it gets done. I think our role as this Panel is to identify the need, and to bring that forward.

And what we've seen and heard is, with the advance in the technology, and there's a real issue as far as addressing how NOAA moves forward to acquire data, and how to best share and integrate that data.

And I think our concern should be at that level, not who to talk with, or what committee it goes to, or who sits on that. But then, I think the broader swath is that we can identify what we believe is a shortcoming right now.

The technology and the various

companies and stakeholders are coming up with very aggressive, fast moving ways, and new ways to acquire data that NOAA can use.

And we have to identify how best to acquire all those different forms of data, how to best classify them, and categorize them so that they can be used on the broadest possible basis across agencies and stakeholders. And I think we need to have NOAA take the lead as far as establishing standards. And that's kind of what we need to say.

As far as which Board, or who to go to, or how that moves, or if it goes to NRC or, you know, or if it goes to the Oceans Board, these guys know how to do that. That's not our concern, to be overly prescriptive as to how to get it done. We just have to identify that need that we see.

And it's an opportunity for NOAA to, you know, move it forward into the future. This needs to be done, very similar to the study that was done in '94, was advising how to move forward.

It didn't say with too much specificity, you know, how they actually get there. I think that's really where we need to go with it as a Panel. We're an Advisory Panel. We're not naming who should sit on the different pieces.

CHAIR HANSON: Go to Dave, then Glenn had a comment as well.

MEMBER MAUNE: Looks to me like there's two ways. Rather than say NOAA needs to establish an independent review process, we can say recommend NOAA determine if there is a need to have an independent review process. And then let them decide whether or not it's necessary.

MEMBER KELLY: And from our perspective as the Panel, we see that that's a gap right now that needs to be filled.

MEMBER MAUNE: Yes.

MEMBER HALL: I'm actually not sure we agree as a Panel. Because I agree with Carol and Andy, where are we getting ahead of ourselves with doing this? And it doesn't mean it's on our committees one week later if everything hits the proverbial fan.

And all of a sudden US Army Corps and NOAA aren't talking. And we go, no, now you need to bring in some external expertise to get this fixed.

I think we do have to let whatever stakeholder engagement strategy that Shep and his office have come up with kind of fully bake. I don't think it's fully baked yet.

But I think that, I actually agree. I think the paper's still salient. I don't think it's OBE. I just think we need to be very careful coming to a conclusion before we see kind of what comes of Shep's efforts.

MEMBER KELLY: Well, I think Shep intimated that this proposal from the Panel would help to impel that to move forward. I don't think this is going to be solved with, you know, a couple of guys from NOAA and a couple of guys from the Army Corps deciding what to do.

Coast Guard's got to be involved. There's outside stakeholders. There's a whole host of people that to really solve this needs a whole lot of thing. And I think Shep could use this Recommendation Letter to move it forward, to say what these are for.

That, look, there's a pressing need. We have our Panel of industrial experts, et cetera, and technological leaders that are saying this needs to be done.

So come on. Let's sit. And let's figure out who else needs to be at the table, and how does that move forward. I think it moves it --

VICE CHAIR MILLER: We've got a comment from Glenn --

MEMBER KELLY: -- forward.

VICE CHAIR MILLER: -- that might provide some good --

MR. BOLEDOVICH: Well, thanks. So first of all, the paper I heard was dated February, so that's the last edit. Shep has now submitted to you folks a strategy on how to take data from other places that's very related to this topic.

I don't know if his views have changed. But I think your comments that he asked for on that might be almost more important than this pending issue paper because we have quite a policy before you. Am I correct on that, I think?

See, there's not, I think there's been an intervening event from the Admiral. Because he's actually asked you now, well, we've put some thoughts out together. And so, now he's asking you to comment on something he's put before you, rather than, just write an issue paper from blank.

In terms of the National Academy, so, I think everyone on the Panel should read the study from 1994 before we kind of move forward on that. Because I kind of agree. I thought it was kind of on charting specifically, and not so much about data, and whose data goes on a chart.

And I'm being a little cautious about inviting other agencies to be a part of a Panel on a topic that we think is solely within the jurisdiction of NOAA, which is the nation's national nautical charts.

I don't want other people to think that they're, we have a statutory mission. We make the nation's nautical charts. So it turns, that would then depend on what the scope of such a study would be this time around.

And that I think is a little mushy here right now. But I would hate to invite other agencies into something that we think we have kind of sole proprietorship over.

Now, if you want to make it broader, just about data, even data standards if it's for chart quality. That's, NOAA already has that. So, I just want to be a little bit cautious.

And I think you'd really, some thought about the scope of the study, and that kind of stuff. These are all good ideas. But I think there needs to be a little bit more thought.

And going back to my original point, I think most importantly, I think the Admiral has put together some ideas that almost kind of intervene on the topic of this paper, and his recommendations for how he's going to go about taking data from other places.

VICE CHAIR MILLER: Well, he has. But very honestly, what I've read to date does not, I mean, it doesn't address the issue that at least the channel's paper is trying to address, is the fact that data from a federal agency is going into charts that does not meet NOAA standards.

NOAA makes the charting standards. And when they give out a contract, I've been one of their contractors, they say, you will survey to IHO standard thus, whatever it is. Special order, never. They aren't able to say that, the Army Corps.

And my understanding is they don't really expect the Army Corps to change their approach. And, I mean, we updated with Shep yesterday, before he left. And he didn't seem to have, you know, he did suggest that we modify the wording of that.

But he did, of that first recommendation. But in no way did he really ask us to remake it. So, I don't know, you know. I don't want to go forward if we don't have good consensus, you know. And we knew he has a summit meeting coming up with them.

MEMBER LOCKHART: I guess, I think the issue with this isn't so much bringing in data from other sources. I think the bottom line is the Army Corps of Engineers surveys don't meet the needs for navigation.

And I think outside of this paper, even in our Recommendation Letter to the Administrator, we can just make a simple statement saying that we think that there should be full bottom coverage and object detection done in the critical channels that we're navigating our commercial vessels.

It's that simple. We don't need to have the entire paper. That can be part of this paper. But I think we can make the statement in that recommendation that that should be happening. Regardless of who's doing that survey, that should be happening.

CAPT. BRENNAN: Yes. And just to comment on what Joyce had said, I mean, the one distinct difference is that the, you know, the federally maintained channel is uniquely Corps area in there. So they have the responsibility for maintaining it. We have the responsibility for charting it.

So, it's a, you know, there's a combined responsibility there that is, that makes it, you know, that puts it into a different category than a commissioned survey that we would, you know, pay for and have performed on our behalf. So, it, I agree with you that --

VICE CHAIR MILLER: It's very ambiguous is what it is.

CAPT. BRENNAN: There's some jurisdictional issues I think that, you know, we need to wade into carefully on that.

VICE CHAIR MILLER: Yes.

CAPT. BRENNAN: And so, I mean, I don't, I'm not here to speak for the Corps. But just to at least make sure that that distinction is clear.

MEMBER LOCKHART: Yes. No, I think we all understand that that's a gray area. But if our recommendation is that that needs to change, then that's our recommendation.

VICE CHAIR MILLER: Well, that was actually my original recommendation, was that things be surveyed to, you know, to the international standards. And in the development of this we went away from that.

CAPT. BRENNAN: Well, and again to -- I know I'm preaching to the choir with Joyce here.

VICE CHAIR MILLER: Yes.

CAPT. BRENNAN: But I mean, just, it technically does meet international standards. It's just not the international standard that we want. You know, it's not a 1A. So it's meeting something less than object detection, right? So I mean, I --

VICE CHAIR MILLER: Yes.

CAPT. BRENNAN: Just again --

VICE CHAIR MILLER: I mean, you're --

CAPT. BRENNAN: Being the petty IHO wonk, I mean, we just need to be clear that what, which of the standards is it not meeting? So just a nuance, but --

VICE CHAIR MILLER: Glenn, did you want to, did you --

MR. BOLEDOVICH: Yes. I just wanted to clarify this. And now I have kind of three issues going on. Do we want an Academy study at some level? Do we want a recommendation on just how NOAA's going to go about getting other people's data onto its charts?

And then the very specific issue of the issue with the Army Corps and the channels. These are three different things. And if the Admiral, and I'll defer to the Captain on this.

If he's comfortable with the paper

you've developed to address that very specific issue, you've worked it out with him -- I'm not really commenting on that US Army Corps-NOAA interaction and how this paper might play. If he's comfortable that this letter will support his interests in that, and you're comfortable with that, I'll defer to Captain Brennan on that.

That's a very, it's an interagency issue. I'm a little -- you don't want to be telling another agency what they think they should be doing in some ways. I'd be a little careful. But I'll defer on that one.

I was speaking a little bit more generally. Because if we're going to go for a National Academy study we need to have this kind of statement of work that Larry was talking about really clearly articulated before we move forward with that.

VICE CHAIR MILLER: I think the suggestion that Dave made is a partial solution. Determine if there is a need to -- for an independent review to review the process. That gives NOAA the out of, they may say, oh, I don't think it is.

MEMBER GEE: But Joyce, I think you should -- I think maybe we should -- I agree with you in that. But I think maybe you should put in what Carol's saying. It should go back. And it's like there's no question it should be -- to be charted, it should be the appropriate standards.

VICE CHAIR MILLER: Well, okay. That being said, on the data issue in the other paper, you've got some academic out in Hawaii, me, who happened to be a hydrographer and could survey to a certain standard.

But because I have no tide data, there was no way I could ever meet the best standards. And I knew that. But a lot of people in academia don't have a clue what survey, what --

MEMBER GEE: Joyce, what --

VICE CHAIR MILLER: -- that standard is. And in the data paper, that's a different thing, Shep's policy that he's talking about in the new documents, the four documents, that we use the best data, well, in the backside of Alaska or Hawaii, any data's better than what you've got.

MEMBER GEE: Yes. So I'm commenting not -- maybe the data paper is the one that's being more overtaken by the, now the paper that Shep's given us. So maybe we sit that one back.

But I think the one specifically on the surveying and charting in the critical channels and navigation, that's the one I think we're discussing now, right?

VICE CHAIR MILLER: Yes.

MEMBER GEE: So that's specific. And I think what Carol's comment about that, it's like that's what it should be. And then, okay, if you want to determine whether there needs to be an independent review Panel to assess that and meet that, well, we include that. And it's ready to go.

VICE CHAIR MILLER: Well, how do you say then that the Army Corps data must meet those standards, but --

MEMBER GEE: We don't say that. We're saying, it's not included in that. You're saying that for charting, it needs to, the data needs to meet the standards for critical navigation.

And then NOAA decides that, okay, if Shep doesn't make progress with it, then he can determine that we need an independent review to come in and assist with that. I think that's --

VICE CHAIR MILLER: Lawson.

MEMBER BRIGHAM: I think the idea of having the National Academy do some sort of study, I mean, it wouldn't be like the '94 study. That was very focused on charting.

I mean, I think maybe we could discuss, I agree with Andy and Glenn that it be a high level study. Future of marine navigation, which is a lot of stuff.

But we'd have to sort out, and maybe provide some of the strategic issues we've learned from our meetings. And pass them to the Admiral, and see if NOAA's interested in having that kind of high level, beyond NOAA, interagency study.

What we're talking here is, I just think that the Admiral's already sent us a paper that we're moving ahead, that the agencies are speaking. I would be suspicious of some independent review actually.

I mean, the agencies that are doing it at the, I see, the tactical level and the organizational authority level. They're doing -- they're addressing some of these strategic issues.

I think the, some Academy study is something different that was kind of thrown out at us. It may be useful because of the fundamental changes in marine navigation. But that's something different but that we could give advice on.

I mean, I'm a proponent of doing something like that maybe if the strategic issues for the country are worthy of having a high level study.

VICE CHAIR MILLER: Susan.

MEMBER SHINGLEDECKER: I would just add, I mean, listening -- trying to listen and take a lot of this in. In the number of years I've been on the Panel, it seems when we made recommendations, for the longest time, we were missing the mark.

And the recommendation we got was, keep it at the strategic level. Don't tell us how to do it. Just keep it at that higher level.

So, if there's a way that we can write the recommendations to be outcome-based. This is the outcome the Panel would like to see or that we think is optimum. We're not going to tell you how to get there. But this is the end result we would like to see.

Then if we see they're not getting there over time, then it's our responsibility to go back and look at those Recommendation Letters and say, okay, which ones have happened? Which ones haven't? Which ones do we need to keep hammering on?

And then it's also on us to talk to the key NOAA staff and say, is there a roadblock that you're hitting? And how can we as a Panel overcome that? And so I almost see this in that order.

I mean, granted, with the Army Corps issues specifically, I mean, I know we talked about it a lot in Charleston. So we've been on this one awhile. But progress is being made.

What's the outcome that we want to see? You know, what's the time frame we want to see some action in, potentially? And then, if we're still not getting there, okay, what can we as a Panel do to help you overcome that roadblock would be my approach on it.

VICE CHAIR MILLER: So, Susan, be specific. What do you think that particular -- that's a nice high level statement. But we're trying to hash out what's -- if we're going to put this paper in --

MEMBER SHINGLEDECKER: And I am not a hydrographer. So some of that is lost on me.

CHAIR HANSON: What Carol said. I think it's what Carol --

MEMBER LOCKHART: Okay, I'll say it again. So I think as a Panel, we've identified that there is a gap in the charting. There's a gap in the data and the surveying we're doing. The critical channels that our commercial vessels are navigating over are not being surveyed to IHO Order 1A, and they should be.

We don't have to mention the Corps. We don't have to mention NOAA. That's the bottom line. They're not being mapped to the standards they need to be for critical navigation.

VICE CHAIR MILLER: What's our recommendation to NOAA, to the NOAA Administrator?

MEMBER LOCKHART: Is that we have to look at how we -- these channels have to be mapped to IHO Order 1A. And they have to look at how to do that.

CHAIR HANSON: I have no problem with that as a big statement. I just want to clarify, does IHO standard have a time frequency?

MR. ARMSTRONG: There's no time.

CHAIR HANSON: So when the Corps surveys channels on a weekly or monthly or annual basis, they're not going to spend the money to do that.

MEMBER LOCKHART: No, they're not.

CHAIR HANSON: But we want access to that data, right? Is that kind of the point?

MEMBER LOCKHART: Yes, we do. But that's a separate issue. I mean, it comes back to what Rick was saying: you have to, if you're going to take that data in, you have to have ways to deconflict that. And that's a separate issue. But I recommend, our holistic recommendation is that should be done to IHO Order 1A.

Whether we ever get there or not is another issue entirely. But as a Panel, I think we've identified that that's what should be done.

VICE CHAIR MILLER: So I repeat, I would love to hear suggestions of what we -- because if you say, it must be surveyed to IHO standards, and we get data that's not -- and we have to modify it within the critical commercial channels and harbors. It's not everywhere. Now so what do we --

MEMBER GEE: Well, we don't do anything. I mean, that's our recommendation. And if Shep comes back and says, like, I can't do it. I'm still having problems doing this. Then that's --

MEMBER HALL: That's what I've been saying. Now you need to figure out the interagency and getting there. And if you can't get there, then you need to tell the industry why they're going to hit objects because you couldn't do the necessary surveys, whoever's supposed to do them.

MEMBER LOCKHART: Yes. This is a process. We're not going to solve this in one day. And Shep's already started working on that process. I think if we put this in our Recommendation Letter, it's just, it supports what he's trying to do already.

VICE CHAIR MILLER: Okay. So here's a recommendation that's included in this. Within five years, implement national standards for surveying and charting of harbors and channels that are consistent with international standards. And --

MEMBER HALL: And this is where you have to mention specifically what we mean, going back to Rick Brennan's comment on there's a lot of standards.

We specifically mean object detection or whatever the words we use. That we think it to this level, 1A, or something that tells us about the objects. But I think that's where it has to be more specific.

VICE CHAIR MILLER: Right.

MEMBER GEE: I'm sure we don't want five years there either. That seems, I don't think there's any time frame. It should be --

VICE CHAIR MILLER: Well, if you say implement, simply, that says now. It can say now. And if you say within a reasonable period, what is that? They've got to have some time to work on it. They know what the standards are, that's for sure, for the international standards.

I also made a suggestion to establish a metric that is every so many years. Because we know that not every survey's going to be to those standards. To survey all federally-maintained harbors and channels with both full sea floor coverage, and object detection at a prescribed interval, for example, five years.

Do those two encompass what -- instead of saying an independent review, do those two encompass what we want to say?

MEMBER HALL: Well, I think there's two separate things here, right. So there's the one where we really want to get to the point of, we believe that it's object detection for critical waterways, for critical navigation, first and foremost.

Second, somebody, NOAA for who we're talking to, needs to develop the roadmap to get there. Whatever the roadmap is, whether it's five years, three years, one year, we say, we need you to develop a roadmap. And again, that gets your stakeholder engagement, interagency, and then a time frame.

CAPT. BRENNAN: I would like to recognize Jon Dasler who had a comment from the public sector.

MEMBER GEE: Yes, he did.

MR. DASLER: Thank you. So I think the big issue here, because we've discussed this with Admiral Smith a lot, is that NOAA is really mandated to take USACE surveys as an authoritative source.

That they go directly to the Marine Chart Division, and they're to be applied to the chart, no matter what kind of surveys they are.

So, single beam surveys, I mean, there's been a lot of issues. And he brought up some of those, where those have replaced critical soundings that were detected by object detection surveys.

So I think the real issue is here, is

how does that mandate get changed, that there has to be better vetting of the Corps surveys. And you can't just carte blanche take all of the survey's from the Corps and use it as an authoritative source. Because they're not consistently acquired the same way.

I think that's the real issue. I mean, just trying to tell the Corps, you have to do it to this method. Better would be to say, NOAA really shouldn't be treating these as authoritative data to replace soundings that have detected obstructions from multibeam, and just apply it to the chart. Because that's been a real problem. Thank you.

VICE CHAIR MILLER: Rick, did you have a --

Well, I think we're at a point where we aren't going to resolve this today. I don't know what our goal is on these two. I will say, again, these two papers have been on the table for over three months.

And I didn't have a single person

object to the independent review team. So please, everybody, if we send out papers for review, review them. Give us your thoughtful comments so that we can do this.

MEMBER HALL: And this is where the telecons help. And sometimes I don't know if we're always prepared or the authors are. Because sometimes I need more context. I need to have the conversation of what did you mean by this.

Because when I read it, I can fix words; I can fix grammar; I can -- but sometimes those substantive conversations like we're having right now need to be the focus.

CHAIR HANSON: Right.

MEMBER HALL: And whether there's just one of the papers, that process matters. Those discussions matter. If we're doing them in a bubble, we're not doing them as a committee. And again, it becomes, a lot of the time it becomes the editing process, not the actual substantive context and content.

So you guys do a great job. But I think that's one of the things as a demand signal to you and Dave to be, let's get on those phones and have substantive conversations. And be prepared to have them.

VICE CHAIR MILLER: Ed.

MEMBER KELLY: Joyce, kind of building on that. I think part of the discussion on our next teleconference or whatever, I think we need to examine the format and the structure of these meetings.

Because I think these types of inside Panel discussions are absolutely essential for us to move forward. We've got to get a Recommendation Letter. We have to decide what our key points are. There's an awful lot to do.

And on a seven-page agenda, our internal discussions are right here. And everybody's going to run out of here for an airplane in about two hours, or not even. So, I think we --

VICE CHAIR MILLER: Yes.

MEMBER KELLY: Looking forward, for meeting structure and whatnot, I think we have to find a better way to have some more time for inter-Panel discussions, other than just the phone calls with somewhat fragmented groups.

Because this committee talked, and the working group was talking. And all of us need to be involved in a lot of this stuff to really make it valuable.

VICE CHAIR MILLER: Yes.

MEMBER KELLY: So and that's not for right now to discuss. But I'm just, I'm going, oh crap. I'm hearing a lot of good stuff. And we're starting to get some substance and some momentum. And in a few more minutes we're all going to go home.

VICE CHAIR MILLER: Yes.

MEMBER KELLY: And we still have a lot of stuff we still have to talk about. So --

CAPT. BRENNAN: So I would just like to make one quick note if, as a part of this paper, if you haven't read it, is the ruling on the shared liability of -- between NOAA and the Corps of Engineers for the Athos grounding and spill.

I think that that's certainly the thing that has -- it's been the game changer in this relationship. And that's been the catalyst that has kicked this discussion off and brought it into much sharper focus.

And so I think that whatever decisions that you make, and recommendations that you make, should be considered in light of that decisions. So just to --

VICE CHAIR MILLER: And I really wasn't aware the magnitude of that shared liability, which he said was $8 million dollars, or 80 --

CHAIR HANSON: Lawson.

MEMBER BRIGHAM: Yes. I had a question for the chairman. I have a, kind of an administrative comment to make about the working groups. But maybe that could be in the next session? Even though this is the working group session. I have one that kind of transcends it. So is that --

VICE CHAIR MILLER: Larry.

DR. MAYER: Just to keep this other discussion going. Or maybe to try to end it. I was just going to throw out a recommendation that may be palatable and meets what I think everybody is talking about, which is simply just establish procedures to ensure that harbors and channels critical to commerce are surveyed and charted to IHO Order 1A standards, including object detection.

I think that's outcome, to come back to what Kim -- that's the outcome that we all want. And that's a recommendation that doesn't tell anybody how to do something. But it gives Shep, if he needs it, the ammunition if the Corps comes back and says no.

VICE CHAIR MILLER: Well, no. I think explaining the issue --

DR. MAYER: Oh, yes. No, I'm just saying that some --

VICE CHAIR MILLER: No. I mean, because --

DR. MAYER: Somebody's statement.

VICE CHAIR MILLER: I mean, I as a Panel member, until about three meetings ago really didn't understand this issue very well. And I doubt that there's a whole lot of people out there that do.

DR. MAYER: No. I'm just going for a bullet. I agree, it should be explained.

MEMBER GEE: Yes. You're talking about a bullet there and in the Recommendation Letter.

DR. MAYER: Yes.

VICE CHAIR MILLER: Yes.

MEMBER GEE: I agree.

VICE CHAIR MILLER: Yes. I think that sounds good. Would everybody have a -- can you give me that sheet of paper? Or --

DR. MAYER: I'll write it neater.

CHAIR HANSON: All right. We need to schedule a short break here. So it said 15 minutes. And I guess we'll try to keep it less than that. But no more than that. 3:15, please.

(Whereupon, the above-entitled matter went off the record at 3:00 p.m. and resumed at 3:19 p.m.)

CHAIR HANSON: All right, if we can get back in action here and wrap up our evening here. We only have about two days' worth of work to do in about an hour and a half.

So just a real quick recap, hopefully, on the issue papers. How it is, we have Rec Paper, right, so we have a win there. Precision Nav is going to go for further review. Our two charting and surveying navigation papers are going to be revised with the review team.

Larry has come up with language, and I will read it to you, that will get inserted and distributed, that is: establish procedures to ensure that harbors and channels are surveyed and are charted to IHO Order 1A standards, including object detection.

No more than that, no less than that.

And with that, we will circulate it. We may have to have a phone call in a couple weeks to get it approved that way, but that's a way forward for that.

So if that's okay with everyone else, we then want to move on to the Recommendation Letter. Joyce is working on it. We have drafted languages in years -- as in meetings past. I kind of want to just get the thoughts on what the Panel thinks should be included in the letter.

We have got four reports that we got from Admiral Smith that really kind of form his thoughts and recommendations, and I think it really fits in line with the discussions we have had this meeting and our issue papers as well.

Granted, we did not have months and months to review them and study them, not that that would make that much of a difference, but we were going to beg a little bit more time to thoroughly complete it, but I think we want to mention that in our Recommendation Letter that we do have them.

We can offer some preliminary points that we have taken away from them, and if we choose to do so, if the Panel agrees to do so, we can do a supplemental letter.

I don't mind -- we don't have to wait for a meeting to have a letter, and if we want to do something in the meantime that responds to some issues that are burning, then we can do that.

So then of course, we have -- hopefully we'll have three issue papers to submit. What else have we got on there, Joyce?

VICE CHAIR MILLER: I think that's about it. I think it would be good, as we have done in the past, to quickly go around and have each Panel member -- I put together some thoughts last night, just based upon the notes.

One thing I think we do need to include in the paper, or in the letter, is acknowledgment of Dr. Callender's presentation of the new NOS priorities, I guess you would call them, and just acknowledge we heard that and that we think that's a good idea.

That would be a suggestion from me. So I think maybe go around to the Panel members, to everybody at the table, and get comments and see how we work them into the letter of recommendation. Scott, do you want to begin?

MEMBER PERKINS: I respectfully yield my time to my colleagues.

MEMBER THOMPSON: I've got to think fast. So I think the theme we have heard a lot is the importance of the NOAA data, so I think we need to stress that in our letter, that every presentation we have heard, it's the benefits of that.

So that would be recommendation, make sure we make -- I am sure they are already aware of it, but make them aware of that.

VICE CHAIR MILLER: Okay. Susan?

MEMBER SHINGLEDECKER: I've got a couple things. I do think that we did get some comments together from a few of us on the National Charting Plan, so we might see if there is a way to work, how we want to work that, but then certainly recognizing the additional documents we have received and our future work on that.

Things that struck me the most were this new policy or the concept of charting the best-available data, and, to me, I mean especially for my users in the recreational world, that gets me really excited, and it sounds really good.

My question is, how hard is that actually to do? When you hear about bottlenecks in processing the data, and so I would like to learn more about how do you put this best-available data on the chart into practice.

And then the other thing that came up, which really it's kind of outside of the discussions we had, yesterday looking at the VTS and how they monitored some of the exclusions, the environmental exclusion zones on the coast, and then looking at the traffic in Puget Sound.

Recently NOAA Fisheries has proposed,

or they asked for comments on a boat exclusion zone on the west side of San Juan Island, and so it was really interesting, a couple side conversations that I had about looking at the congestion in that area and how that will happen. And it was just great to be here in person to see and talk to some of the stakeholders that are directly involved in that.

And while it is not really related to these three offices, it certainly is a NOAA issue.

VICE CHAIR MILLER: Ed?

MEMBER KELLY: Yes, I was kind of impressed this meeting with, it just seemed to hit me, the amount of new technology, the amount of various data sources, how people are using this data. And I think it's just imperative upon us to stress in the Recommendation Letter that NOAA needs to be in a leading -- to strategize to take a leading position as far as how to shape the future of data acquisition standards and usage as the country moves forward, obviously within international constraints and considerations.

But I think that is a very key area that seems that people are becoming aware that there is a lot of that stuff going out there, like with ActiveCaptain and, you know, just the LIDAR stuff.

The technology is becoming more efficient and cheaper, and there is a lot of outside players that are starting to produce data, and I think we need to have NOAA find the appropriate ways to incorporate that data into the future vision of charting and surveying.

VICE CHAIR MILLER: Okay. Just a second. Okay.

MEMBER KELLY: Then I had some drivel that makes no sense anyway. I can't even read my own notes, so you know.

MEMBER HALL: I think probably as we have -- I have been kind of a squeaky wheel, so I will leave my other recommendations for kind of the operation of this group, and we'll talk about that later, I'm sure.

So that's really where my mind has been as we have heard things, we have seen things. And again, enjoying having that technology Panel today.

But I think the big thing that kind of resonated with everybody and everybody really -- I'm not sure it was aha moment, because it almost a Captain Obvious moment, but the best data available approach that Shep advocated. And so I don't know if there is something we can do, because it did resonate so highly with all of us, or if Shep needs that little bit of backing saying we highly encourage that this approach be what they do. Because I think when that incoming leadership comes in, we need to make sure that NOS has all the support to ensure that that is something that will be supported.

Whatever that ends meaning. I don't even think we know what it means, but to ensure that Shep, Juliana, and Rich, everybody gets the support they need to ensure that we have that.

So again, that kind of best data available, support that approach.

VICE CHAIR MILLER: Okay. Kim, would you mind taking a look at the Improving Data Access?

I am not sure that we have that phrase in there, best data available, but that's something we could easily incorporate into that existing paper if we wanted to. That would be my --

MEMBER HALL: I still think it has kind of a spot for what came out of this meeting in that Recommendation Letter as an overall concept.

VICE CHAIR MILLER: Okay.

MEMBER HALL: So I mean if people don't agree, that's fine, but I think, again, it was almost a no-brainer, but I think it's something that this group would highly support.

VICE CHAIR MILLER: Okay. Rich?

MR. EDWING: So I always enjoy these meetings. I always learn a lot during these meetings. But I think this meeting set a new highwater mark, if I may use that term, for the --

(Laughter.)

MALE PARTICIPANT: That's your political statement?

MR. EDWING: But in a number of ways. I mean, I thought we had some really high quality Panels that really brought up a lot of issues, raised some provocative items, and there was a nice balance between discussion of the local applications and issues all the way up to the strategic visioning, way into the future, and I think that's really where the HSRP needs to be, so I was very appreciative of that.

So I think we ought to maybe take a look at this meeting and what are some lessons learned and how to craft how we approach some of the future meetings going forward and set new highwater marks.

MEMBER MAUNE: My comments pertain to processes. The Planning and Engagement Working

Group has been meeting once a month, the last Tuesday of every month at 2:00 p.m. Eastern Time, which equates to 8:00 a.m. Joyce's time, and so that ought to -- somewhere in between ought to be appropriate for everybody.

But each month we have somewhere around, Joyce and me and maybe three other people, and a lot of people I get the impression you may not even read these issue papers until you come here when you have been having the opportunity to do so all along, and I am wondering can we do something that might work more effectively.

For example, this morning Ed mentioned maybe he's having too many meetings, doing one every month, and maybe I and Joyce are having too many meetings, because you get so many, you may not pay as much attention to each of them. And maybe if we had your meeting in May, my meeting in June, your meeting in July, my meeting in August, with everybody expected to participate, maybe we would have better in-depth and more full involvement in these things.

And then I think, is there anything to prevent us from if we have our final review of the issue papers in August, sending them to NOAA to have them comment on the issue paper before we discuss it in September?

Is there anything to prevent that? Because it would have helped if we had known that Shep agreed or disagreed with our issue papers before we walked in here, because there was some discussion today, not sure if he endorsed what we were recommending or not, and we don't want to do something that he vehemently opposes, and it would help if I knew we had his blessing with these things before we gave our final blessing on it when we get together.

Those are my recommendations, that maybe we should meet monthly at some established time. We have been doing it the last Tuesday of the month. When have you been doing it, Ed?

MEMBER SAADE: First Thursday of every month.

MEMBER MAUNE: Well, if we could agree on either Tuesday or Thursday, it doesn't matter much to me. I'm just not available on Wednesdays, so either of those are fine with me.

If we could just all know that we are going to have one meeting at such and such a time every month for one or the other, maybe we could lock it into our calendars and get better participation.

MEMBER BRIGHAM: I see it as the working group of the issues papers. It's all the other -- involves the whole of the Panel. That's the way I view it, and it has evolved.

I mean you are chairing this working group that is dealing with issue papers, but when we are talking about where we are going to have the next meeting, reviewing the National Charting Plan and stuff, I don't think that's a specialty thing.

I think that's the work of the whole of the group. So I have, and I don't want to be too critical, but I don't think this Working

Group on Engagement and -- Planning and Engagement, I mean it's kind of the work of all of us, but of course, not everybody calls in, but I don't know. That's my tactical issue.

Because I think working groups, I have been here since the evolution of them all, and they are a specialty thing. Yes, their specialty is gearing up on the issue papers and Arctic and technology, but it isn't the Administrator stuff for the rest of the Panel. Sorry, I have a different view of it.

MEMBER MAUNE: Yes, but --

VICE CHAIR MILLER: Well, actually, we haven't had any or many meetings in the last -- since the last meeting, of the HSRP, and the working group meetings have kind of taken that over.

And, for instance, I would be very happy if someone else would take -- besides Dave and I -- would take lead on the review of the National Charting Plan, the four documents that we have been given.

Dave and I can't take, we can't take responsibility for everything, and so that's one of the things we need to think of in the frequency of our meetings and what we need to do between now and the next meeting.

So that's my response to what Dave said and to what --

MEMBER HALL: I just have one request, because I think this is a conversation about how the HSRP works, not a conversation about what your -- what our, I'm sorry, not your -- our Recommendations Letter is.

So I guess I just as we go around because I really want to make sure we get that out, what did we learn at this meeting? What came out of this meeting? And then we can work on our admin stuff.

I have a lot of recommendations for that and I don't want to go into all that and -- yes?

(Off microphone comment.)

MEMBER HALL: No, I understand,

Lawson. That's not slight on you, I just want to make sure, as we go around --

(Off microphone comment.)

MEMBER HALL: No, Lawson, I'm sorry, that wasn't critical of you, just as we are going around maybe we put a timeout on this one.

CHAIR HANSON: Let's start with the other end there. Captain Rassello, do you -- I'll let you come in at it this way.

MEMBER RASSELLO: Yes. I think with the National Charting Plan, we have a solid ground to work forward. We don't like anymore these words precise navigation.

We can call it optimal navigation or something like that that expresses the needs of everybody, not just a large vessel but also a small vessel, because if you are talking about shallow water, they need the precise navigation, too.

What can I say? Regarding the process of the paper, I really feel helpless because I don't know who should drive that.

You're right, you should not be the only doing that, and I feel sorry, but it's difficult to do that over emails, probably better to do it with the one conference call every two months or whatever we need to do to prepare and finalize.

Give it more time probably because people are busy with other tasks. I don't know about that. One more thing, I think we all agree that the charting is approaching a new era, and we need to find a new structure to charting for ECDIS.

ECDIS has set the standards, but I think we can improve that, and there are good stuff I have seen, and I thank you all because I always learn during this meeting about new technology, new things, and open my mind how to implement these on our cruise ships.

There is always a way to improve, and there is always a way to -- this charting, the ECDIS only sets the base standards. Then we can amplify that according to the needs.

So I will say for the next six months maybe, we should work on this chart, like Admiral Smith said, including also the pier side.

We want to go all the way to the pier. We don't want to just chart the channel and that's it. We need to see for each needs, probably select a few ports, major ports in the United States and work on those ones and be more selective.

I don't know if everybody agrees with that, but --

VICE CHAIR MILLER: I am not sure I understand, Sal. You need --

MEMBER RASSELLO: If we want to continue talking about precise navigation, if we don't want to call it that anymore, we can call it a different way, but in the end, the safety of navigation for a larger vessel or a small vessel is vital for the economy, for the people, safety of the environment.

So therefore, I think that we should select a few ports and work on those ones and be more selective, probably they will be more sounding when we express that in the paper, and not generalize the precise navigation for the entire territory.

I don't know if that's -- is that clear? Good? Thank you.

MEMBER LOCKHART: Okay. At the risk of sounding like a broken record, I think IHO Order 1A and the critical channels is not just, does not need to just go in the issue paper. I think it should be in the Recommendation Letter to the Administrator.

I also agree that using the best data available is an appropriate approach, and I think some of us think that that's -- some of us on the Panel -- I don't know, maybe I am reading this wrong -- may think that that's contradictory to what I just said.

It's not. It's in addition to that, and so I support both things.

MEMBER BRIGHAM: Yes, thank you. I had two issues. I think that we should report that the Technology Working Group, I mean just -- Let me step back.

Working groups have had some inertia in getting started and gearing up over the history of the HSRP in the near-term history, and so this one we geared it up. It's working.

The important thing that they did differently is they engaged with the NOAA team, had a bunch of briefings, and now are -- and will have some very important reports that will contribute new knowledge to NOAA.

So in some words, that this Technology Working Group is, we think, has lots of potential and has the right people, of course, and all that.

The other issue is the issue papers. I mean you've heard from me, I think they are useful, but I also think that there's an element of transparency to the public with them. And they are kind of 101, and so they're on the website; people can read them. But the most important part is what Scott mentioned: you get your input right here, that this is a record, a public record, of the work of the current members of the of the Panel.

So I mean I think it's very important that we have reports that are on the website, Arctic now, technology reports, and all the issue papers, but we are showing it is a true public record, so that's very important. Thank you.

MS. BLACKWELL: So I don't have a specific recommendation to add, but I do have a request, and that is I'd like to hear from the Panel, the non-NOAA folks on the Panel, what types of things that you would like to hear us report out on or not for our next meeting from the NOAA offices.

And so one of the things that I heard was more of a discussion, perhaps next time more information, and not too technical detail on VDatum or something such as that, and I think it would help us.

And we don't necessarily all have to have the same exact format. If there is something in particular you would CO-OPS to present on or have a Panel on or something, that would be great.

But I think it would be nice if, rather than us trying to guess what you want to hear, if you all would let us know what would be most valuable to you in the use of your time, our time, the next time we meet. Thanks.

MEMBER SAADE: Okay. I heard lots about partnerships, especially the first day. I think that's important, and I certainly support the whole concept and the themes that were presented.

Obviously, ROIs and transfer of technology is -- I don't think we can say enough about that, and we need to emphasize it more and recognize it more.

I am sorry we didn't get a chance to talk about Seabed 2030, because I think it would be a good thing for us to support, but it's kind of nothing we can put in there right now, and maybe that's a topic for when we all get together in one of our technology meetings.

And I just want to recognize that with everything going on in Washington, we are kind of in uncharted waters, but I would like to think that there is a whole bunch of people in this room that made their careers working in uncharted waters. So we are going to be okay.

MEMBER GEE: Yes, first I'd like just to respond to -- I certainly am one of those people, Juliana, who would like to hear more about VDatum and how that's being done across the different groups.

I really appreciate, this time I think more, maybe -- I've only been to two meetings -- Shep's engagement and that having the papers that came from him, I think that's really helped because we don't really know what NOAA does in a way. We don't know the details as much.

And the more that we can have some information about that, the better, and the more openness that we get. So I really appreciate that and certainly will be commenting.

One of them about the data, and I think the best-available data, I think that sounds as a first pass I would say that's a great policy. I am interested in our next step of the implementation and how that's going to be done, of course. That's something --

I think that the Governor is -- I really appreciate his presentation. That was something just to give a focus in the area and Washington State has brought out a number of things of the activity and the scope of it in Washington State and how far that extends.

Again, I think the Panel that Shep led -- and generally, I think it's going to be a real balance for the meetings in the future. I think the ones where I got the most value was when we had the discussions, whether that's a technical discussion or just about the future, or as we are having now, we have limited time, which we can talk about that later.

But I think that was a really important Panel, and that sort of set the theme for the rest of the meeting that came out that we all could engage in at a level of understanding of that topic.

That was really -- that would be a key thing. The engagement we had this time I think was important and the time to discuss those things.

That's probably -- I'm not going to talk about the technical. You've heard me say things about technical stuff all meeting, so I'm not going to say anymore. Thank you.

MR. ARMSTRONG: So I echo what many of the Panel members have said already. I thought the Panels that we had were excellent, and I think the key was that all of them kind of set up discussion among the board, the HSRP, and so I thought that was the most valuable thing about those Panels is they stimulated our conversations.

And I also want to say how impressed I was with the Holland America control center. I was just blown away by that. It's really impressive to see what the state of the art is on monitoring and supporting ships at sea, so thank you for that.

VICE CHAIR MILLER: Larry?

DR. MAYER: You go near the end, and almost everything has been said. So again, I think it -- I am a relative newcomer, not to the Panel but to appearing, and there's a long story behind that.

But I think, again, the Panels were just great here, and so I thank whoever organized that. I think it was just a really good choice. Once again, he's right, lots of great discussion.

Again, I am continuously impressed as we hear from stakeholders. Clearly, people value NOAA data and acknowledge the value of NOAA data. I think there was a general consensus about the merit of the National Charting Plan and the concept of using best-available data.

That leads to some challenges, and the challenges was really one of the major themes through the meeting, and that's the challenge of integrating disparate data sets. It's a nice way of putting that we have problems with other data sets sometimes.

I was also happy, and I think it's something we might even mention, that we are seeing the beginning of discussions to take advantage of new technologies, autonomous vehicles, crowdsourcing, even, to me, thrilling, the discussion of the Chart of the Future. It will help us in the lab quite a bit.

And my final comment was very much like Andy's, having seen the Fleet Operations Center, I am now quite prepared to go on a Carnival cruise and with great confidence that even if the captain isn't there, somebody else will take care of things.

VICE CHAIR MILLER: Yes.

MEMBER HALL: And so you actually want to take Holland America, Sebourn, Princess, or P&O. I don't think your op center is up and running quite yet, right?

Almost, right.

CAPT. BRENNAN: So I am not sure if Admiral Smith stated this clearly enough, but just to make sure that I set expectations with the papers, particularly the one that talked about the Coast Survey Ocean Mapping Strategy that came out on Monday, that is a very raw document, and you'll see that as you review it.

The Admiral had asked for this within the month, and probably even within the last several weeks, so it's been drafted fairly recently, but I think what he thought was that it was really important to give you a glimpse into what our best thinking is today on that topic and where we are going and what we are doing on it.

And so I think he didn't -- he's a real proponent of perfection is the enemy of the good idea on that. So I think he wanted to get that out even that very raw state to make sure that you saw it.

So I say that just so as you review it, you understand where it is, that it's a work in progress, and it's literally a snapshot of thinking corporately for us today. So that's the only thing I would add.

VICE CHAIR MILLER: I really, I'm trying to sort of see what, if there is anything from my notes that has been missed.

MEMBER HALL: Joyce, can I say one more thing?

VICE CHAIR MILLER: Yes.

MEMBER HALL: So yes, from what I have heard, because I know I am still a newbie, there are several of us that are still within our first year of being on this Panel. We have seen the improvement, and we had a pretty -- fairly high bar there in Galveston when we first showed up.

So I can appreciate that and where we are evolving, and I think that's what we all have to kind of accept and be okay with it. It's not always going to be the same.

One of the things I have, and I think the Panels were great, but I think there is still something missing, and what that is is the context and background for those people who are speaking to us, because quite often the folks get up there, and they are speaking to NOAA.

We are not, the Panel itself, NOAA. The DFO is here; sure they are NOAA. We've got Juliana and Rich and folks who are non-voting members, but I think sometimes it's speaking to us what can we do to help propel those hydrographic services, things that you would need.

It's great to hear the good news story. We are proponents of NOAA. We know the good news story. And it's always good to have that background and hear it again and again because when it's not good, then we hear it even louder amongst the noise of everything being okay.

So I don't know if that means we develop some priorities for each of our meetings, the topical priorities, so that when we are asking the speakers to speak to us, they know what we are currently thinking about, because you can give the background HSRP. It's a group of experts from industry who are looking at things, and I think that can easily go you are doing a dog and pony show.

And I think a lot of us really love the executive director from the Pilot Association, but we all can spell PPU and we know what it is, and that's not a fault of hers.

I think that we can get farther with some of those conversations and some of those presentations if there is a little bit more context, and I am putting the onus on us to maybe give that background: here are our top five topics that would fit into anybody who is going to come speak to us.

CHAIR HANSON: Right. And just to add to that, one of the things that we can do is ask them to answer the question, why are you here and what can we do for? What can the Panel do for you?

MEMBER HALL: Right. And I think that question gets asked, but the answer in terms of what can NOAA do for them, not what HSRP can do for NOAA.

And there is a little bit of a nuance there, there is a difference there, in what we can do versus asking NOAA to do more charting, to do more of this, do more of that.

We hear that sometimes but it gets bogged down, and I think loses kind of our ability. We see some of the same things. We know some of the same things, so if they know they are speaking to industry or service providers, then it's a different presentation that you are providing.

So I just kind of want to -- I mean Larry and the whole technical, other than maybe Marten, but he still did a great job, they knew who they were speaking to, and that was the most interactive Panel that we had. Not just because we know each other but because it was where we knew where to start from. It didn't have to start from necessarily 101, how to spell NOAA. It started at the next level up and was really good. So just kind of one suggestion overall.

But I think it was great speakers. I think we could help those speakers a little bit better.

DR. MAYER: Yes, I think that's a really outstanding idea. When the speakers are invited, are they explained what the FACA is and what its role is? I think that would be a really -- okay, all right, they get that, okay, good, all right. Because I think that would help.

VICE CHAIR MILLER: Well, and I would also say that Lynne often asks in the P&E Working Group what suggestions we have for speakers and what we would like them to tell us.

MEMBER HALL: I think we have done that. And then sometimes we don't understand -- like I know that when I asked in Cleveland, knowing we were coming to Seattle, I asked about APL and then I got told it was too hard to get there and a couple of things.

There was never kind of a full kind of complete circle to tell me, no, we're not having anybody. So I was really surprised not to have something about autonomous vehicles this meeting, to be completely honest.

I said that in Cleveland, I said it on at least one of the P&E calls. I don't know how many times we are supposed to say, no, we really are interested in this.

So maybe it's an email goes out and we help amongst ourselves prioritize subjects we want to hear about. And if there just isn't somebody in the place that we are going to that can talk about that then that needs to be communicated.

MEMBER GEE: Are we finished with the Recommendation Letter or are we moving on to --

VICE CHAIR MILLER: No, and I think we should wrap it up.

MEMBER GEE: Yes. I'm doing that to you.

VICE CHAIR MILLER: Yes.

MEMBER GEE: No, I have some comments I just want to make but I didn't want to go off on a tangent.

VICE CHAIR MILLER: Well, I think we need to get the Recommendation Letter under control.

MEMBER HALL: Sorry. The only reason I mentioned it was because everybody praising the Panels, and I think that it is, but I think there is some little things we can do to make them --

MEMBER GEE: We can add a little two-page paper for the Panel members coming.

VICE CHAIR MILLER: Yes. One of the things that hasn't been mentioned that I had noted, I found the geodetic, we often -- I have to say I feel we terribly neglect NGS and CO-OPS sometimes in terms of their importance.

And I found that people -- I found the guy from the Tribe really interesting, you know, what's a tidal benchmark, Lord, I don't know, you know.

And the importance of the underlying data to the infrastructure, that was one thing after Dr. Callender spoke that I don't think we need right now another issue paper, but maybe in the future down the line, you know, a paper.

We don't have to write every issue paper is a problem. We could write some of them as, wow, guys, you do this really well, like the NRTs or the -- So I think we need to -- and I am hoping if you give us some presentations and maybe we have a geodetic Panel next time that we could get some.

But I found the guy with the benchmark and the white thing, I know some people thought it was not useful, but, you know, I found that useful, and the --

MS. BLACKWELL: The white thing was an antenna.

VICE CHAIR MILLER: Yes.

(Laughter)

MS. BLACKWELL: It's a GPS or a GNSS antenna.

MALE PARTICIPANT: I thought it was a flying saucer.

MS. BLACKWELL: Usually connected to a receiver.

MEMBER HALL: I like thingie better. I like thingie better.

(Laughter)

VICE CHAIR MILLER: I knew what the benchmark was. Yes, so at any rate, just the importance of the NGS and the tide data to the community and the amount of support it provides for the nation's infrastructure, I mean bridges and roads and not just the wet side.

So I'll give you a shout out and maybe -- Bill, do you want to finish up?

CHAIR HANSON: No, I think you just did great. Recommendation letter comment or --

(Off microphone comment)

MALE PARTICIPANT: New stuff.

CHAIR HANSON: Okay. All right, well, we do have a little bit of time for new stuff. We've got a couple other housekeeping items I want to get to before that and then we will go around the room one more time for things that are left on your mind before you run to the plane.

VICE CHAIR MILLER: I think we should

discuss what our -- I mean we've had a lot of good comments. What are the top two or three things that we want to recommend in this letter?

I think Larry's statement about establishing the IHO Class 1A, I think that should be in there. Another one I had a suggestion of, and so many people referred to it, is the importance of NOAA data, the need for more NOAA data, and the need for it to be seamlessly served somehow, that's also in the rec voting paper.

MEMBER GEE: Yes, can I say in that when we talk about a data infrastructure and make sure it becomes part of the infrastructure. Now that's all of the data, whether it's the CO-OPS, the NGS, that framework, is more than just the charting products, which people are used to, it's now an IT and a data infrastructure.

VICE CHAIR MILLER: Okay.

MEMBER GEE: It's kind of -- Okay, it's from my viewpoint on that.

VICE CHAIR MILLER: Okay. Anybody

else with a high level --

MEMBER PERKINS: Yes. I will use the remainder of my time.

VICE CHAIR MILLER: Okay.

MEMBER PERKINS: I really appreciated the presentation on the Chart of the Future and what can be done with the visualization of the available data.

And I think Sam Debow's comment, you know, I think there is some meat there, so I would ask the Panel to consider requesting of NOAA a strategy for implementation or roll out of a more visual chart, you know, and I think what's the 10-year plan for the Chart of the Future.

CHAIR HANSON: Dr. Brigham, go ahead.

MEMBER BRIGHAM: Yes, I think the issue of the public record and the issues papers and the technical working group reports and all of that is public record, record of the contributions to the Panel, so I think it should be stated.

It's not self-serving, it's just the

thing is working and the working groups are working and we are producing products that are useful to the nation and hopefully to NOAA, but I actually think more to the country, the synthesized little issue papers.

But, anyway, some comment about the public record issue. We're going to keep going around after, right?

CHAIR HANSON: Yes, sir.

MEMBER BRIGHAM: Thank you.

CHAIR HANSON: You can reserve your time.

MEMBER BRIGHAM: Well, I just want to beat on one topic.

CHAIR HANSON: We'll have some time.

MEMBER BRIGHAM: Hmm?

CHAIR HANSON: Did you get what you need for --

VICE CHAIR MILLER: Just let me sort of give you a framework of the outline that I at 2:30 this morning, because I couldn't sleep, came up with.

Of course, we acknowledge Benjamin Friedman, and I'll have to get accurate details of his title and everything, and let's see, we met in Seattle at the normal -- One question I have strategically, should we include the names of the staff representatives or only that they were from Senator so-and-so's staff?

CHAIR HANSON: Bosworth.

VICE CHAIR MILLER: Yes. I don't know if that's important, but --

CHAIR HANSON: I think we would want to mention Senator Murray.

VICE CHAIR MILLER: Senator Murray, okay.

MEMBER PERKINS: There is a meeting transcript that gets prepared, so I don't think you've got to put too much fidelity of that in the letter.

VICE CHAIR MILLER: Yes, okay. Well, we also -- The format we established last time, let me just -- Lynne and Shep were pretty adamant they didn't want a summary of the Seattle meeting in the letter, and so we moved that to an attachment, just a brief summary, two, three pages of highlights, and so the letter really is our recommendations.

So I mention Joshua Berger, the Governor's Maritime Industry Sector Lead, and Senator Murray's staff. I then mention Dr. Callender's safe and efficient transportation preparedness and risk reduction, stewardship recreation and tourism, and make some statement that we find these appropriate and easily understood, or something like that.

In the past several years a robust dialogue between HSRP and NOAA has developed and it has become clear that HSRP could make better recommendations if involved in this dialogue at an early stage, and then I go and say we now have these four documents to review.

You know, we're not going to get it done in the next few weeks, but we intend to come back within say two or three months with comments on the National Charting Plan and the other three documents. Does everybody think that is doable?

MS. MERSFELDER-LEWIS: We have a deadline on the National Charting Plan.

VICE CHAIR MILLER: When is it?

MS. MERSFELDER-LEWIS: By June 1st, cannot be later.

VICE CHAIR MILLER: Okay, so June 1st, all right. So that has to be our first priority I guess is getting that done. Anybody going to step up to coordinate that?

MEMBER HALL: I'm curious, and I am sure I am starting a battle here, but as the HSRP, I mean I understand that that's the FRN, right, the June 1 is for the Federal Notice?

MS. MERSFELDER-LEWIS: We would appreciate it if you guys would submit your comments in that same timeframe.

MEMBER HALL: Okay. I'm just -- Yes, because if it's due to the FRN actually as the HSRP, but now that I know it's what Shep, you guys want, okay, I just wanted to make sure.

VICE CHAIR MILLER: I am looking for

hands.

MEMBER HALL: I have to rewrite a precision navigation paper or else I would have.

MEMBER SHINGLEDECKER: Joyce, I'll do it.

VICE CHAIR MILLER: Thank you, Susan. And then we need to get the other three reviewed, but, Dave, I don't -- Do we want to take that on in P&E?

(Off microphone comments)

FEMALE PARTICIPANT: Yes.

CHAIR HANSON: What's the other ones we got?

VICE CHAIR MILLER: Okay. So then I mentioned the three papers that we are going to submit and right now I have three recommendations.

The first one would be Larry's statement about establish the IHO, a comment on the importance of NOAA data and the importance of centralized data access, and then who was it that wanted something about plan for the Chart of the

Future? Is that at the level of a recommendation or --

MEMBER BRIGHAM: Yes.

CHAIR HANSON: Yes, I think so.

VICE CHAIR MILLER: Okay. And then I thought I would add -- And I need to incorporate some of what we just --

CHAIR HANSON: Can you go back up to those four plans, you only got one volunteer.

VICE CHAIR MILLER: Right. Chairman?

CHAIR HANSON: Yes, do we do it alphabetically or do we partner up. We have three plans to take the lead on.

MEMBER PERKINS: I will volunteer to take the lead on the autonomous paper.

CHAIR HANSON: Thank you, sir.

VICE CHAIR MILLER: The autonomous vehicle --

(Simultaneous speaking)

VICE CHAIR MILLER: External data source data policy?

CHAIR HANSON: And hydrographic survey

are the other two on your survey.

MEMBER SHINGLEDECKER: I'll also take the external source one.

CHAIR HANSON: Wow, she set a standard for you.

(Laughter)

(Off microphone comments)

VICE CHAIR MILLER: That really now is, it's more the 30-year -- I can sign up for that one this time. I just didn't want to sign up for all four of them.

MEMBER SHINGLEDECKER: Joyce, I had a comment on the tone of the letter itself. It strikes me that potentially this will be the first document that an incoming Administrator reads from this group, potentially, who knows.

And I just wonder if we want to think a little bit about the tone and I mean I kind of wrote down words like, you know, underscore the importance to infrastructure that these offices have and underscore the things we heard about the technology advancements and the efficiency gains.

I'm just thinking are there key buzz words that will resonate with this Administration that we want to make sure are kind of up front to set the stage for the kind of -- to get their interest basically.

VICE CHAIR MILLER: Yes. I actually in the first paragraph have the words infrastructure and dah, dah, dah.

MEMBER HALL: Do we have national priority, too, based on what we heard from Glenn about actually we are one and, you know, kind of appreciate that these services are seen as that? That might be something as well from Glenn's presentation at lunch.

(Off microphone comment)

MEMBER HALL: Yes, reiterate that it is a core, key function.

VICE CHAIR MILLER: What's a key function?

MEMBER HALL: Charting, the hydrographic services.

VICE CHAIR MILLER: Oh.

(Simultaneous speaking)

MEMBER HALL: Whatever the wording was that came out of the President's budget, skinny budget, let's reuse that for their advantage.

VICE CHAIR MILLER: Yes, I know what you are talking about now. I just wasn't quite done with it. Okay. And I will try to as much as possible in the space of two pages to summarize the valuable comments.

I don't think we want to talk too much about the process of the Panel there.

(Off microphone comment)

VICE CHAIR MILLER: No. You know, I, you know, we want to establish that we are interested in the national priorities and here is how we can help and, you know, words like infrastructure that mean something to the Administration.

Okay, I will work on that. I will probably have it out a week, or I will have it to Bill in a week, and then we can review it. Our goal is usually that we get it in final format, it's one month I believe what we established as procedure.

MEMBER PERKINS: Less than 30 days is what we agreed to and is in our --

VICE CHAIR MILLER: Yes, I mean one of the tricky things is I mean we have to send it to the Acting Administrator. We don't have anybody else to send it to, so --

(Off microphone comment)

VICE CHAIR MILLER: It is.

MEMBER SHINGLEDECKER: Just to comment on timing, once we get through the priorities of the Recommendation Letter, seeing that I did take on two of those documents, I think that we've got the momentum, a lot of these issues are fresh in our heads, so I think that we should reconnect and make significant progress on those four papers quickly before we lose the natural momentum a little bit, so expect to hear from me soon.

VICE CHAIR MILLER: The Charting Plan, actually one thing I did want to ask, there were a couple things about the Charting Plan that I thought we might easily say.

Let me see, where was I. You know, although we haven't had time to review all four documents, some very early comments on the National Charting Plan was updated performance measures for targeting charting discrepancies, you know, for updates.

I think there was a general consensus that they should definitely show soundings rather than remove them and I would defy anybody to not want to transfer to metric because -- Do you think those are high enough comments that we can, you know, as a first level comment in this letter, because Shep did ask for high level and those were things that were in our response to the Charting Plan already.

So, Susan, you have a pretty good starter. You should review what Shep asked for though, you know, because he did ask for specific things.

(Off microphone comment)

VICE CHAIR MILLER: Yes.

MEMBER BRIGHAM: Just a question about process. Not all of these individual tasks are going into the report back to the Admiral or they are?

VICE CHAIR MILLER: What's that?

MEMBER BRIGHAM: For all of these projects that people are working on throughout the Panel are post-work of this meeting, right, but not all -- Now everything everybody is doing are going to input in the next week or two to this report to Shep, is that right? I didn't see it that way, but --

VICE CHAIR MILLER: No, no, no, no, no, no.

MEMBER BRIGHAM: Okay. Okay, so let me finish, please. So it's process?

VICE CHAIR MILLER: Yes.

MEMBER BRIGHAM: It's the entire Panel working on all these issues?

VICE CHAIR MILLER: Yes.

MEMBER BRIGHAM: It's not some working

group -- Let me just state clearly, I don't think the working group on planning and engagement is needed or effective of whatever.

The working group on issue papers is and needs to be driven by a competent chair and whatever, but the rest of these issues are kind of holistic.

We send them out electronically and then the Panel should have a discussion about it or the electronic submissions are coordinated by the chair and the vice chair.

I mean a couple options, but can we have a meeting and chat about the input we get together or can we not do that? I don't know whether it's public and who knows what the administrative rules are to do that, but I don't think it's a working group of the Panel, it's the entire Panel.

MEMBER HALL: We can have pre-deliberation discussions, which is what we kind of do on these things, but I completely agree with Lawson on that, where it needs to have the conversation because part of the reason, and I know that, Joyce and Dave, you guys take such a huge load when you helped with those issues papers.

I feel kind of out of, a fish out of water when I get them and I look at them. And, again, like I said earlier I know how to edit them, I don't necessarily know the context of having those conversations as we all haven't had a chance to read it.

We have some of our initial thoughts. We have some really good things that come out of, oh, shoot, you know, Lawson said something that just dawned something for me or Lindsay said something.

MEMBER BRIGHAM: Yes.

MEMBER HALL: I think it's really important to have it not just our individual inputs to you, whoever is doing it, but that there be a conversation about it.

Now we all have to do our homework and read it. It can't be a what is thing once we get to the phone, and I think that's where the pressure --

(Simultaneous speaking)

VICE CHAIR MILLER: Right, I agree. But I have to give Dave huge, huge -- I mean there is a reason this -- What was your rank, Dave?

MEMBER MAUNE: Colonel.

VICE CHAIR MILLER: Colonel. And the Army can say, you, write a paragraph, you know, and that's really --

MEMBER MAUNE: You don't have to volunteer.

VICE CHAIR MILLER: Right.

(Simultaneous speaking)

MEMBER MAUNE: They volunteer by making a recommendation.

VICE CHAIR MILLER: Yes. Yes, but it really does take, I mean somebody said it's not herding cats, it's bathing cats, so --

(Off microphone comment)

VICE CHAIR MILLER: Process, yes. So

at any rate, I just give the folks warning that have signed up for things you've really got to push it and you got to give people schedules or it will be nothing coming back.

MS. BLACKWELL: Joyce, I am a little bit confused now with, not the last statement, but specifically for the request to review and provide comments on the National Charting Plan.

Is that something the HSRP is doing as the HSRP and you all are going to get back together again and hold a meeting and vote on or deliberate or whatever the right word is --

(Off microphone comment)

MEMBER SHINGLEDECKER: Yes, and the last, on our last --

MS. BLACKWELL: -- and then submit that on behalf of the HSRP?

MALE PARTICIPANT: Yes.

MS. BLACKWELL: Okay.

MEMBER SHINGLEDECKER: That was my understanding. On our last planning and engagement call I think there were four people who volunteered to submit specific comments.

Joyce compiled that as a starting point. My intent was I would take that and then maybe we'll schedule a conference call or I'll reach out individually.

Honestly, I'd love to have a Google doc where we could collaboratively edit it if possible, but, yes, develop something together and that would be comments from the HSRP as a whole.

If individuals also want to submit comments on their own that option exists as well.

MS. BLACKWELL: Right. And so I guess maybe we just need to check on the proper protocol for this, because if you are going to hold another discussion formally and vote on this as a final product that has to be, that has to go with the DFO and you've got to do everything right.

So I just want to make sure that we are following proper procedures.

MS. MERSFELDER-LEWIS: I'd recommend

you guys go around the room and talk about the National Charting Plan. You probably have 70 percent, or even 80 percent, of the total comments you are going to receive right now.

I suggest you go around the room and people make comments.

CHAIR HANSON: We've got a few other housekeeping things we'll take care of and get there.

MS. MERSFELDER-LEWIS: All right.

CHAIR HANSON: Yes, I don't mind doing things. I do like doing things as HSRP, on the other hand we do have the FACA rules and there is ways to work that.

It's not unheard of to have a call with the DFO on a call, we do that in other groups, if that's where we want to go. So I kind of like that idea.

I do think that going to these committees is helpful for specific purposes, but we need to stay focused as a group.

MEMBER BRIGHAM: A comment about that,

but to use the working group as a mechanism to avoid, it's not what we are saying, but the appearance is is that we are using the working group to not include the entire -- It's disingenuous, I have to tell you.

CHAIR HANSON: Yes, and I don't --

MEMBER BRIGHAM: That we've had -- With Admiral Glang we had a couple meetings where the whole Panel met. Sure it's a nightmare to get hooked up to have the public engaged, but we did have a few people onboard.

I am just concerned about the scope of this working group which is the scope of the Panel.

CHAIR HANSON: Okay, got it.

(Off microphone comment)

CHAIR HANSON: No, we got it. Okay, so one more time around, and I've got a couple things I want you to address. Scott, no deferring your time this time.

No, you guys go first. It's actually better to go first, you've got more to say, right.

So the two things you have to respond to before you get into your wrap-ups, and I'd ask that we be respectful of each other's turn here and interrupt if absolutely necessary, but otherwise hold for your turn.

If you have any comments on our charter, we have gotten very few comments on it so the chance is to accept as is. Number two is topics for New Hampshire.

At this point we got talk on autonomous vehicles and we got a half day or a full day tour of the facilities. So beyond that, after you address those two issues, then you can have at it.

MEMBER PERKINS: I have no recommend changes to the charter. I think it's fine as presented. Topics for New Hampshire, you know, autonomous vehicle, you know, positioning, that interrelation of how can we pre-position NOAA as the positioning navigation and observation agency, you know, to be, to increase that visibility of the importance of the role of NGS, you know, in providing those services in support of autonomous movement, be it land, air, or water.

MEMBER THOMPSON: No changes for the charter and I think I am the one who you're supposed to send it to, too, so I think I'm set.

Topics, 2022 is not that far off so I think we need to talk a little more this next meeting about getting prepared.

MEMBER KELLY: I'm good on the charter and I think since we are going to be up there with a bunch of very smart people, they are doing some innovative things, perhaps we could have them make a presentation on innovative charting presentations.

Some of the stuff we saw just briefly was just fascinating and, you know, it's kind of new stuff, cutting edge, I'd like to see more of that.

(Off microphone comment)

MEMBER KELLY: That's what I mean, I'd

like to see a little bit, make that as a, something for innovative charting presentations.

MEMBER HALL: No changes to the charter, I think it's pretty good. The topics for New Hampshire, you know, I mention again the autonomous vehicles.

I would love to see the gliders in action if at all possible, kind of cool. And then the other one, I know I think we have mentioned it, the VDatum, but just that Datum 101, I mean at a level that it's not completely--

MALE PARTICIPANT: Yes.

MEMBER HALL: I mean something like what Carol did today with bathymetry, the LIDAR stuff, because that was kind of one of those things were, you know, some of it, half of it over my head, but the little pieces that I got I know a lot more about LIDAR than I did before, so I think that would be very helpful.

And then, you know, just my process comments that I have had all along. I am not sure we are still kind of figuring out what an issue paper is versus perhaps what an informational paper is versus perhaps what the moment in time, which I think the Technical Group, that longer paper is kind of really actually documenting, you know, the thought process of our Committee.

I'm not sure our issues papers always do that, and that's okay. The issue papers are a separate thing and a specific thing, we have an issue, this is we would like you to address this issue.

So maybe, you know, I don't know, we're not going to resolve that in the next, you know, half hour, but I think we need to make sure we get moving and momentum on what that is.

So, again, it gives us context for when we are reading a paper and trying to help edit it and trying to give our feedback.

And the second thing is is just what I said earlier about meeting preparation. I would love to be part of it, other than just giving topics.

I mean actually talking to folks and saying, hey, this is who we are about, this is what we would like to hear, if it's a thing like that, and us prioritizing so that we can give those folks, hey, here is the top five things that we are all interested in.

I am on the NMSAC, the National Maritime Security Advisory Committee, and before every meeting we do that. It was really interesting because we had a topic that I brought up and it turned out very surprisingly to be the number one topic for everybody.

Nobody had thought about putting it on the agenda, but it helped in the preparation of that meeting to go, okay, they really want to know about this key thing in this timeframe, and it helped for somebody to bring it.

And it was just a quick email back and forth where somebody listed it and somebody did the math on which one was the top one and went from there.

So just a little bit more. I am happy

to be hands-on. I want to be, please use me. Thank you.

MR. EDWING: I want to second what Juliana suggested. I am the ocean service representative to something called NOAA Observing System Council and I am also the co-chair of the Observing Committee underneath that.

And the NOSC is really charged with ensuring that NOAA responsibly, you know, manages its large observing system portfolio. All three offices here have observing systems and the operation and maintenance of those observing systems take up over half of NOAA's budget.

So you might be interested in just learning a little bit more about how all that works, but, also, this last year in July we put on our very first Emerging Technologies Workshop, which is more of an internal workshop, but this next August we are putting it on again and opening it up to private industry to come in as well and do some presentations and I can provide some more information on that.

But I just offer that up as a topic you may be interested in hearing about either, you know, this meeting or, I mean, you know, one of the upcoming meetings.

MEMBER MAUNE: Okay. I have no comments on the charter. As far as the September meeting, if Rick concurs, I think it would be appropriate for us to give a presentation on the upcoming NEEA update and hydrography requirements and benefits study, what its goals and objectives are, how we propose to go about doing it, and maybe get some feedback from the Panel on what that study is all about.

I wanted to second what Kim said about the issues papers, just because I defined what an issue paper was doesn't mean we can't something other than an issue paper, such as an information paper, on the technology transfer, that sort of thing. That's all I have.

MEMBER RASSELLO: No further on the paper. For the future I can only give my support as the technical issues, whatever you decide to work on.

CHAIR HANSON: Any cruise ships in New Hampshire?

MEMBER RASSELLO: Uh --

CHAIR HANSON: You're on a roll.

MEMBER RASSELLO: Baltimore or New York, that's the closest I can get.

CHAIR HANSON: That's all right.

MEMBER LOCKHART: No changes on the charter. What I would like to hear about, autonomous vessels, datums or datums, including epochs or epochs, depending on what you like.

And I would also, I think it would be helpful even though it's not necessarily directly applicable, it abuts what we do, and that's the global seabed mapping initiative. I think it would be good for this group to hear a brief on that as well.

MEMBER BRIGHAM: No more input, I inputted on the charter, so no more there. New Hampshire, I really request to have an Arctic Panel. It's my last throw at this before I depart in January.

So we have world class Arctic expertise there, but I want to report out and talk a little bit about it with some background on this electronic coast pilot.

And then there would be other topics, work with Larry and the NOAA staff on what Arctic things, what Arctic strategy, and give it some profile, maybe get some of the congressional delegations in to think about Arctic.

A couple other small items, we could get a letter to the Washington State, to the Governor, Commissioner, for the two individuals who gave very professional and very enlightening talks on the State's position.

And then a recommendation for issue information, all, whatever kind of paper it is, public private partnership, we have them, with PORTS, and I'm pointing at Richard, sorry, to point, and then we have the Marine Exchange.

I think an informational paper or issue paper that -- I mean people talk about them all the time and nobody knows what the hell they are, generally.

So we have some examples within NOAA, and maybe outside NOAA in the maritime world, and then we could then have some recommendations on what are we talking about here, because I think it's political, it's timely, people are talking about public private partnerships, so throw it out on the table as a new one.

MS. BLACKWELL: I don't have any recommended changes to the charter and I have no other comments for the next meeting. Thanks.

MEMBER SAADE: Seabed 2030 and the X-Prize for the next meeting or maybe we'll do it as one of our briefings every other month.

MEMBER GEE: Yes, I have no comment on the charter and I would support the VDatum and the autonomous subjects in the next meeting.

And just regarding the meeting, generally I think we have talked about how it's a meeting and we need to be able to discuss and having a good period of that.

And I heard the comment about we have a full-day meeting at CCOM and I am sort of torn here because I think from a technology point of view I think it's important that people see it, but that's a long time to take out of a 2-1/2 day meeting and I'm not sure that we should do that to be honest.

We need to structure it so that you can get the view of what's going on there in addition to just Larry's kind of presentation today, but, also, we need to meet there, I think, and so that has to be public.

One of the other issues I think, I'm not quite sure, the lunchtime speakers are great --

(Off microphone comment)

MEMBER GEE: Yes. I want -- But, anyway.

MEMBER HALL: We had talked about this earlier, it's great, but that kind of keynote sense that we get, it's information, but it's -- These meetings are information overload anyways and that's one more of kind of a distant thing where I am trying to decide is this what I am going to assimilate into my brain for what I am going to do in HSRP or is it something that I've got to kind of take interesting and move on.

And I think there is some things that we could do during lunchtime, including an actual working talk, and use that as meeting time. You know, maybe the first day we have, it's always great to have Glenn, so I don't want Glenn's presentation to go away because I think we all really enjoy that and get a lot out of that.

MEMBER GEE: Yes, I think that's --

MEMBER HALL: And I do know that we have enjoyed like when Ed did the Fugro, the mission, kind of specialty MH, or the Malaysian Air, yes, that was really interesting.

But I think really we need to kind of see what else we can do with those lunchtime because having keynote, while interesting, I'm not sure it actually truly adds to the work of the HSRP.

MEMBER GEE: Yes. So I think I was saying there it would be more of the discussion time is what I think we need. We all see that as a benefit.

For the directives, I think what Rich was saying, and Juliana, I think what Larry did today, because he sort of selected a topic area instead of doing a report of the general what he did, I think if that's okay with the rest of -- I think if Rich and Juliana maybe, you know, Shep, there is the general level of we want to hear what the latest is with you, but then if there specific things that, you know, we think we can hear from you it would be worthwhile.

And I just say the more we can get from you, and that's where I support all of the papers that Shep and his time that Rick and all those have provided us, getting that early is like us giving the presenters something early, it's the same thing, we want to see it as well.

I'm not sure regionally -- I really appreciate getting some of the regional issues, and I guess that's part of the way we do it, but there is a balance I think and -- Like I'm just trying to, I guess the take home from that is I really think we don't give ourselves enough time for meeting, like we are rushed at the end here for, you know, a couple of hours.

I don't believe that's enough, so if we can massage the meeting a little bit to do that through the meeting it would be good.

MR. ARMSTRONG: I don't have any comments on the charter, but I just would say that we can be very flexible at UNH and how we want to structure the day there.

We can make arrangements to have parking available for the public if that's necessary. If we want to hold a public meeting we can make arrangements to have part of the time in executive session, you know, however the Chair and the DFO want to structure that I think we have the flexibility to do that.

So, you know, it doesn't need to be an all-day tour. We can condense that as necessary for the needs of the Panel.

DR. MAYER: I have no comments on the charter. Again, it's fine, and I sadly will not be able to be at the New Hampshire. So I shouldn't comment, but I think the idea of certainly autonomous vehicles is a good one.

I like the Arctic idea. I wish I could be there to hear that discussion. But, also, I'll plant a seed for not the next one but sometime in the future, and I haven't discussed this with Andy, but I wonder if at some point we should look at the status of hydrographic education. It's something that is critical to us all and --

(Off microphone comment)

CAPT. BRENNAN: I would I guess, yes, and that the other thing that is afoot right now is a change in from the NSPS hydrographer certification and I think where that's going, or the direction that we are seeing that being pushed, naturally has to go hand-in-hand with the educational component of that, and so those two together I think are a powerful topic to have.

DR. MAYER: Together, yes.

MEMBER GEE: What's NSPS?

CAPT. BRENNAN: National Society of Professional Surveyors.

VICE CHAIR MILLER: I have no comments on the charter. I think we probably need to vote on that, but everybody said no comments, so I think we are there.

Actually, I have a question for Juliana. What is the plural of datum, because in data it's data?

MS. BLACKWELL: Datums.

VICE CHAIR MILLER: Thank you. And I definitely would support the Datum 101 and I look forward to coming up to New Hampshire because every time I go up there it's like, ah, really, so -- and too bad Larry won't be there. That's my comments.

MEMBER BRIGHAM: Just one more. I mean a full court press on the congressional staffs, maybe a full court press to get either a

Maine or a New Hampshire senator or congressman.

You know, we had the congressman down in L.A., hugely positive when he came, and I think the congressional delegations there are all our friends and they would be right on this topic, so full court press for the congressional people, including the senators or congressmen.

CHAIR HANSON: And I can tell you that that has been attempted the last two go-rounds, so any influence any of you can have as well is appreciated.

So I guess I get the last word, huh. A couple of things, I guess to fulfill my own request, no comments on the charter. Do we need to vote on it do you think?

VICE CHAIR MILLER: I believe we did last time when I was in charge of it.

CHAIR HANSON: Okay. Want to be in charge again?

VICE CHAIR MILLER: Yes. Gary?

MEMBER THOMPSON: I can make a motion that we approve the charter as written.

CHAIR HANSON: Okay.

MEMBER MAUNE: Second.

CHAIR HANSON: Any opposed?

(No audible answer)

VICE CHAIR MILLER: All in fav?

(Multiple ayes)

CHAIR HANSON: Any opposed?

(No audible answer)

CHAIR HANSON: None opposed.

VICE CHAIR MILLER: Whatever.

CHAIR HANSON: All right, it's approved. Great, thank you, very official. For New Hampshire, in terms of the education piece, I would like to see if there is a spot for Diane Foster and an ocean engineering discussion.

(Off microphone comment)

CHAIR HANSON: Already a part of it?

(Off microphone comment)

CHAIR HANSON: All right. No, we can find a spot in the agenda for her, so that would be great.

(Off microphone comment)

CHAIR HANSON: Yes, exactly. So we've got a lot of do-outs, a lot of work to do. Everybody has got a long flight home, so I know you will be focused on getting these things done.

I really appreciate the feedback on the meeting. We learn a lot every meeting about how we can improve. Again, Lindsay, I can tell you we're spot on in terms of wanting to utilize the Panel more.

I am really proud of the way you guys have responded the last couple of meetings, very -- Nobody is shy, which is a good thing, and you are all professional. So I appreciate the comments and you are certainly experts.

And that's the point, and one of the things we do ask the speakers is to, you know, if you have 30 minutes, use 15 for your presentation and give us 15 to comment and talk, because that's really what this is meant to, to leverage that mutual expertise.

So we will continue to look for that and look for opportunities for our dialogue. It does seem like we get pushed at the tail end trying to do these issue papers, Recommendation Letters, and having done this for quite awhile I think that's kind of when we do our best work, to be honest with you, we actually get to some conclusions, sometimes it's up, sometimes it's down.

On the other hand, certainly, in the world we live in each one of us likes to prepare and likes to be thorough. The only way to do that is to make it a priority, and certainly the work that Dave and Joyce have put into the issue papers is phenomenal and I -- Go ahead, deserve a round of applause just because --

(Applause)

CHAIR HANSON: And then have the frustration of, oh, yes, let me pull it up and take a look at it.

VICE CHAIR MILLER: Yes.

MEMBER MAUNE: May I recommend a round of applause also to Lynne and the people who put this meeting together.

(Applause)

VICE CHAIR MILLER: I have a question on issue papers. Lynne, or Kim brought this up earlier today. We have SOPs that we did, oh, three meetings ago on letters and when we get them out and Kim suggested the possibility of do we need to establish a process of writing these papers. I don't know. I just thought I'd throw it out.

CHAIR HANSON: All right.

MEMBER HALL: What I thought I might do, because I know that it's one of those, it's hard, it's easy to say yes or no right now without knowing what that might look like, I have something that is outlined actually for another committee that might make -- It's not super involved, it's not going to require a lot of editing, but just to give an idea especially as we are going to bring new members on, I assume for the September meeting, it would very helpful -- No?

Or, whatever, in 2018. It would be

helpful to have that documentation because if you try to come into this group and you're not really sure, I mean that's why I always thought it was just for the Administrator because I didn't have a succinct, clear vision for what they were.

And I think there is several different ones, and I think that's okay, but having that written down, a one-pager, I think would be very helpful as we move along.

So if people don't mind other than vote yes, no, we don't want it, let me provide it and then if you say this is a waste of time that's okay, I am using it for something else anyways, so it's not a waste of my time. Thanks.

CHAIR HANSON: Yes, I've got a couple more things, so --

VICE CHAIR MILLER: Okay.

CHAIR HANSON: So, again, yes, that would be great. And don't be bashful, also, if you have other suggestions about meetings and, again, make suggestions and if we can work them in we will.

So issue papers, I didn't hear any new issue papers. Maybe I did?

(Off microphone comment)

CHAIR HANSON: We did, okay. But we do have a lot of work to do on the reports, right, feedback, so I think that's plenty to chew off for this go-round.

I do expect to hear some more issue papers coming out of Tech Transfer. I think that remains probably a very exciting area for us. The innovation discussion, it's going to be an overused word in the next year or two, and so we need to stay focused with what we think that looks like for us.

I think one of the things I would like to hear as it gets talked about is we are going to run across bureaucratic impediments to innovation and we need to be able not just to define the science, but also what is NOAA's role in innovation, are they set up to handle innovation.

Now I think they are, I think they've

got that big thinking, but we need to make sure that if there are bureaucratic impediments that we identify those and get to work on those, just identifying them so we can deal with those.

And one other thing I would like for you to think about on your plane ride home is folks in our industry, respective industries, who have skin in the game, and the reason I say that in terms of advocacy for what we do both bureaucratically, for funding, for policy, there are folks that have access to the Administration at a very high level and those folks right now are the folks that have skin in the game, and it's not service providers, it's not dredgers, frankly, it's not surveyors, but it is people who have, we own boats, who own equipment.

So we were talking about the boat manufacturers, you know, you're talking about shippers, you're talking about manufacturers. Folks like that have access at very high levels right now.

So if -- When you're getting your

plane ride you need to look around the room, I bet each one of us come up with half a dozen folks at a very high level who benefit from the work we do and who need to, or ask, they need to be able to walk into the White House and say, boy, here's three bullet points we would love for you to take care of for this innovation piece, or, you know, empower NOAA to do this and Arctic.

So, anyway, it's not just a service discussion, it's who really has true skin in the game. So I talked about that before, so I will leave that be for now.

But I will go ahead and --

(Off microphone comment)

CHAIR HANSON: Oh, yes. So, something to be thinking about is in the course of for the next meeting, is three of us will be falling off the HSRP, Scott, Dr. Brigham, and myself, and so you need to be thinking about who will secede me, that's all stuff that you guys vote on.

So discuss among yourselves. It's obviously better if you reach a consensus, but that doesn't mean you can't have a vote, so if that's the way you choose to do it, but just something to think about, who might be appropriate that is -- It's truly an honor for me, but I will save all that stuff for later.

For now I just want thank Captain Brennan, all the other NOAA folks who showed up. Having you guys here, both the leadership and staff, is really important to the overall discussion.

I also serve on other FACAs and when you don't have staff there you don't have decision-makers, you end up looking around the room a lot, and having you guys here in the room able to say, no, that won't work, or that's a bad idea, or that's a great idea, is really, really helpful to us, so we really appreciate that.

Colonel Maune already gave Lynne the praise and thanks that she richly deserves for putting up with for setting these things up and then setting up the monthly phone calls, so we all appreciate that as well.

Other than that I don't have a lot more to add. We will be convening a phone call within the next month.

MEMBER MAUNE: Can I have 30 seconds?

CHAIR HANSON: I don't mind. I'm sorry, sir.

MEMBER MAUNE: A couple of people mentioned the need for a Datums 101. For anybody who feels strongly enough about it I can give you a Datums 101 at the end of this meeting and it would be over in 15 minutes.

So just stay here and I'll get it right on the spot.

CHAIR HANSON: There you go. Well, that shortens the meeting already next time, right. We're on a roll. All right, everybody safe travels home.

I really appreciate the time and effort and congratulations, great meeting. Thank you. Meeting is adjourned.

(Whereupon, the above-entitled matter went off the record at 4:42 p.m.)

A

A-squared 160:18
a.m 1:12 4:2 112:21,22 309:3
ability 31:20 44:5 86:2 119:9 121:1 234:4 236:17 260:21 330:8
able 25:17 30:1 35:3,8 37:6 38:22 46:4,5 49:5 53:4 64:3 84:4 91:10,11 93:4 94:16 95:2 119:21 127:18 130:12,14 156:13,17 157:10 173:11 175:12 182:4 185:3 217:14 217:18 230:8 231:1 234:9,10 235:20 236:16 237:18 240:8 240:18 242:22 274:17 366:21 371:4 379:18 381:5 382:15
above-entitled 112:20 213:2 299:3 383:21
absolute 227:11
absolutely 61:10 69:2 69:20 235:5,12 238:15 294:13 357:5
absorb 136:18
absorbed 124:5 136:17
abundance 55:19
abuts 364:15
academia 280:17
academic 147:8 162:20 261:4 280:12
academics 197:3
academies 263:20 264:5,12
Academy 248:18 251:14 256:4 272:17 278:14 279:15 282:12 283:13
accelerated 108:19
accept 97:22 204:18 327:17 357:9
acceptance 27:12
accepted 6:12 35:17 36:10 69:19 200:7 240:7
access 11:11 64:7 80:20 245:14 247:13 255:12 287:8 307:5 342:21 380:11,20
accessible 90:22 201:15
accident 149:16
accidentally 56:13
accidents 60:16
account 29:3 79:8 139:22 140:19 252:18
accounting 29:2
accuracies 131:21 132:15 163:12 191:17
accuracy 111:17,22 131:16 132:22 158:10 161:2,5 163:7 164:1 192:4 251:2
accurate 50:9 51:4 121:7 145:17 152:7 157:19 158:6,17 245:16 250:10 339:2
accurately 122:17
achieve 75:8 95:2 163:11 260:8
acknowledge 168:17 301:22 324:16 339:1
acknowledgment 301:20
acoustic 179:4 254:16
acoustically 29:20
acoustics 31:12 32:15
acquire 11:20 12:7 74:16 250:10 267:14 268:3,5
acquired 219:5 292:6
acquisition 304:21
Acting 2:15 347:7
action 37:12 285:12 299:7 359:8
Actions 3:19
active 219:8
ActiveCaptain 15:22 305:6
activities 53:9 76:18,19 83:2 166:15 180:7 250:5
activity 72:9 76:12 79:19,21 87:17,19 198:19 199:6 322:11
actor 56:14
acts 26:5
actual 46:22 129:10 132:11 135:1 143:4 144:2 145:4 147:22 153:9 293:21 368:7
ad 204:13
adamant 339:21
adaptable 48:6
adapter 71:8
add 5:14 6:18 89:12 134:14 135:3 211:16 212:19 220:5 256:11 257:20 284:3 319:10 327:2 329:15 333:8 343:6 383:2
added 118:12 119:8,11 119:11 134:17 135:5
adding 53:5
addition 87:1 317:19 367:10
additional 42:16 118:12 221:9 303:2
additions 4:15
address 15:10,13 17:7 18:7 40:14 53:19 182:14 274:9,10 279:1 356:19 357:14 360:10
addressed 181:1
addressing 214:12 267:13 283:11
adds 123:11 182:8 368:21
adjourn 3:21 112:17
adjourned 383:20
adjust 31:6
admin 313:17
administration 1:3 72:20 241:2 345:2 346:18 380:11
administrative 296:20 350:16
administrator 2:9 22:9 206:15 261:22 275:16 286:16 312:9 317:12 344:15 347:7 378:4
Admiral 2:7 4:8,8,11 10:17 29:11 190:4 213:20 219:6 239:14 244:8,20 246:4 272:11 274:2 278:21 282:22 291:11 300:12 316:2 326:2,8 349:4 356:8
Admiral's 201:18 283:4
admit 10:3
adopted 42:13
advance 6:21 193:11 267:12
advanced 79:9
advancements 344:22
advantage 46:1 143:9 156:12 325:7 346:4
advantages 144:12 159:1 177:9
advertise 7:15
advertised 194:3
advice 167:22 283:18
advising 268:22
Advisor 2:11
advisory 180:10 215:12 269:5 361:8
advocacy 202:16 380:9
advocated 306:10
advocating 254:13
affect 139:11,12,14,16
affordable 263:6,12
afoot 371:17
aft 66:22
afternoon 4:13 5:14,20 6:14 92:5 95:14 181:3 181:4 190:17 191:2 196:2,7 205:1 213:14 218:15 244:8 247:16
age 89:10 90:17
agencies 87:10,21 88:2 88:11 96:15 112:11 229:1 248:6 249:11 250:17 252:19 258:6 262:4 263:10,11,19 263:20 264:4 268:8 273:2,13 283:5,8
agency 88:15 263:11 265:11,11 274:11 279:10 357:22
agenda 5:8 12:16 294:17 361:14 374:20
agents 78:11 86:12
aggregate 261:16
aggressive 268:2
ago 12:17 65:3 67:9 111:8 132:2 146:9 150:7,19 159:13 163:1 211:18 217:17 298:5 377:5
agree 7:17 54:15 103:12 183:14 187:18 212:21 238:17 248:6 251:16 253:9 263:5 265:18 267:1 269:21 269:21 270:12 272:20 276:17 280:4 282:16 298:10,16 307:17 311:1 315:9 317:13 350:21 352:4
agreed 223:9 260:14 310:9 347:4
agreement 99:22 109:12 223:22 236:4
agrees 301:3 316:10
aground 92:15
ah 372:17
aha 306:8
ahead 13:2 44:7 45:10 85:6 93:11 94:14,17 196:9 214:6 239:10 241:12 265:22 266:1 269:22 283:5 337:15 376:13 381:13
aid 49:9
aids 40:15
air 139:6,10 142:6 183:6 215:21 216:1

358:3 368:17
Airborne 114:20
aircraft 118:3,4 135:10 135:11 139:12 140:5 140:9 156:13
airplane 294:20
airport 95:13
AIS 84:18 91:17
Alaska 59:4 70:4 155:8 155:13,14 281:3
Alaskan 154:20
alerted 87:14,17
Aleutian 184:9
algae 149:19 155:20
algorithm 229:12
algorithmic 237:20
algorithmically 229:5 237:18
algorithms 129:6 182:4 226:17 238:1
all-day 370:22
Allen 221:20 222:1
allow 83:22 105:6 107:15 141:9 175:13 184:21 217:6
allowable 56:4,10 132:9
allowed 30:9 119:10
allowing 13:5
allows 40:21 82:7,18 94:7 143:18
alluded 198:5
alphabetically 343:12
also- 203:21
alternate 211:5
alternatives 94:11
altitude 158:1 159:2
altitudes 131:4 157:22
AMANDA 2:18
amazed 42:3 163:15
amazing 29:14 47:16 52:17 145:12 150:6
ambiguous 276:19
ambitious 73:20
AMEELE 2:19
America 5:22 323:21 325:19
America's 215:17
American 102:7
ammunition 297:17
amount 32:16 52:17 70:8 93:10 139:21 194:10 198:9 248:9 304:15,15 335:7
amplify 315:22
Amsterdam 76:4
analogous 251:20
analogy 68:5
analysis 58:5 78:19 79:10 80:17 90:12 175:7 191:12 230:5 230:21 252:7
Analyst 2:18
analyze 78:22 181:21 230:17
Andy 2:1 3:6 14:20 16:20 19:11,13 41:11 42:13 50:4,5,5 53:19 54:16 265:1,19 269:22 282:16 371:11
Andy's 325:12
Angeles 95:19 142:18 217:14
angle 139:14
angles 125:17 144:10 165:8
animation 22:12
Anne 170:16 243:4
announced 220:21
announcement 193:18
annual 168:21 287:4
anode 82:20
anodes 82:14,19,21
anomalies 118:18
anomaly 119:16
answer 53:19,22 55:3 68:19 69:22 113:20 147:19 150:11 178:1 179:2 216:2,4 329:17 329:21 374:4,8
answered 206:5
answers 218:13 243:2
antenna 334:14,18
anticipated 219:19
Antwerp 76:4
anybody 5:4 28:8 131:11 150:11 169:21 210:18 297:16 329:13 331:22 336:22 341:9 347:7 348:11 383:8
anybody's 185:22
anymore 61:13 73:20 90:17 131:19 137:9 149:20 314:12 316:16 323:11
anyway 57:5 58:17 154:8 258:6 305:17 338:6 367:18 381:9
anyways 367:22 378:14
apart 156:10,11
APL 331:18
apologize 178:16 207:22
apparently 89:14
appearance 356:3
appearing 324:8
applause 150:15 165:22 376:14,15,21 377:1
apples 164:11,11
applicable 114:17 167:7 364:15
application 8:8 19:22 23:3 24:15 27:4 39:8 86:6
applications 13:9 22:7 23:4 25:6 35:2,3 43:7 49:11 117:16 308:12
applied 23:3 27:17 291:15
applies 89:5 101:12 199:9 239:4
apply 79:22 86:17 92:20 154:19 198:18 199:22 200:3 238:19 292:13
applying 237:1
appreciate 243:14 321:13,21 322:8 327:15 341:16 345:12 369:22 375:5,13 382:17,22 383:18
appreciated 337:5 373:11
appreciative 308:15
approach 40:12 42:17 47:15 68:17 87:6 90:10 96:12 102:22 127:4,5 134:10 179:10 214:12 220:20 233:1 260:1 274:21 285:15 306:10,14 307:2 308:18 317:14
approaching 315:10
appropriate 19:5 20:8 21:13 22:13 36:17 39:4 42:11 43:6 51:20 55:9 180:18 191:2 214:1 234:7 280:8 305:12 309:5 317:14 340:11 363:8 382:4
approve 373:22
approved 300:3 374:12
APRIL 1:9
AquaMODIS 137:22
architecture 174:17 242:6,8
archive 91:18
arctic 59:21 183:18,20 184:9 185:2,6 312:8 319:6 364:21 365:2,7 365:8,10 371:7 381:8
area 15:18 27:21 28:11 59:3 66:12 78:12,14 80:6 83:17,22 84:3 87:19 88:2 92:5 103:19 128:3 137:17 138:18 142:2 146:12 148:16 153:6 155:8 176:2 183:21 184:7 221:14 222:5 223:14 223:17,18 225:9,9 226:4 228:16 232:15 232:20 234:1,5 263:1 263:15 266:5,22 276:9 277:7 304:5 305:3 322:9 369:7 379:10
areas 7:8 17:8 51:12,22 57:19,20 82:3 83:12 83:13 84:20 112:6 117:9,10 125:6 135:15 138:10 140:17 141:15 142:5 148:9 153:3 154:7 156:17 164:8 184:18,19 197:18 203:1 223:13 226:2,13 249:18 251:7 254:2
argument 238:5
arguments 127:3
arm 219:22
Armstrong 2:1,11 3:6 24:4 35:20 36:3 42:14 44:10 45:13,20 52:19 53:21 265:2 287:2 323:12 370:10
Army 114:19 119:15 244:10,14 247:3 262:10 263:7 270:4 270:22 274:18,20 275:12 278:19 279:3 281:22 285:6 352:10
arrangements 370:14 370:17
arrive 84:14 88:18 96:1
arrives 85:4 87:14
art 46:2 324:1
articulated 279:17
artificial 37:5
Asia 74:2
aside 257:20
asked 18:8 31:11 34:22 202:14 222:4 231:16 237:15 248:13 272:5 272:12 304:1 326:8 329:21 331:16,17 348:19
asking 33:13 65:21 215:22 217:1 265:4 265:16 272:13 328:20 330:4
asks 331:11

Aslaksen 2:10 113:10
asleep 114:8
aspect 47:6 54:19 56:22 83:4 89:2 91:2 185:10 202:13 239:5
aspects 91:3 252:9
assemble 228:20 229:9
assembly 93:16
assess 281:18
assessment 137:19 138:11
asset 74:19 76:11 77:6 79:21 81:22 82:7 83:1 83:20 84:8
assets 75:4 76:11 94:18
assimilate 368:3
assist 282:9
Assistant 2:9
associated 147:11 172:21 173:1
Associates 110:22
Association 5:18 329:6
assume 209:16 377:19
astounding 145:15
Athos 296:2
ATMOSPHERIC 1:3
attached 17:19
attachment 340:2
attempt 114:6
attempted 373:9
attend 5:3
attendance 168:12
attention 194:2 212:7 309:18
attenuation 138:2
attract 76:1,5
attribution 237:3
audible 374:4,8
audience 7:2 178:11 189:10 216:21
audiences 246:7
augmented 20:16 46:3 46:10 47:7 170:9,10
August 309:21 310:4 362:19
Australia 6:1 175:7
authored 190:12 243:19 244:6
authoritative 64:2 104:14 248:22 251:20 251:22 291:13 292:5 292:11
authority 283:10
authors 293:7
automate 84:22 86:19 228:10
automated 85:17
automatically 41:16 226:18 227:4,7 233:15 260:19 261:13
automating 79:17
automation 175:17 180:16 181:10,14 228:12
autonomous 91:6 159:4,16 164:14 169:18 181:8,15 182:2,6,10 183:5,5 210:6,9,14 325:7 332:1 343:15,17 357:12,19 358:3 359:6 364:11 366:18 371:6
autonomy 180:17 181:14
AUV 39:9 40:3 159:12
AUVs 159:14,17
availability 50:20 63:5
available 57:5 68:15 81:2 90:8,21 96:15 99:17 104:14 105:7 141:14 168:15 177:21 247:9,12 259:20 303:15 306:10 307:2 307:7 311:3 317:14 337:8 370:15
Avenue 1:12
avoid 356:2
avoided 40:9
avoiding 55:17 56:2
aware 45:4 48:14 70:14 107:17 115:18 170:7 180:8 190:13 203:14 208:3 296:14 302:16 302:17 305:4
awareness 49:11 76:8
awesome 206:22
awful 11:21 294:16
awhile 214:3 216:10 285:9 376:3
ayes 374:6

B

B 160:18,22
Bachelor 17:13
back 4:9,13 11:6 17:7,9 27:22 28:1 30:6 31:17 31:21 46:13 51:16 52:15 62:12 64:19 65:22 67:8 71:21 96:16 105:4 112:14 112:17 124:5 131:1 137:9 138:19 140:6 166:7 172:3 175:7,12 179:13,14 192:10 199:14,17 200:18 202:11 205:3 209:7 209:16 220:8,19 225:21 228:16 230:9 232:14 241:5,17 245:4 257:12 274:1 280:6 281:8 284:19 287:11 288:7 289:9 297:13,18 299:7 318:2 340:21 343:8 349:4 353:4,10 361:18
background 43:1 47:3 190:20 198:3 219:11 244:5 327:22 328:13 328:22 329:12 365:4
backgrounds 18:20,21 257:18
backing 306:13
backscatter 24:19 124:17
backside 281:2
backtrack 121:15
backwards 125:20
bad 219:14 372:18 382:15
bag 235:16,16
bake 270:10
baked 270:11
balance 308:11 322:15 370:2
ball 264:15
Ballroom 1:11
Baltimore 364:6
bands 227:1,2,6 228:13
bandwidth 23:13
bar 327:14
barb 21:16
barbs 21:15 22:4,4 24:2 24:6
barrel 221:8
barrels 221:7
base 7:4 141:2 165:11 315:21
based 4:21 21:4 81:3 86:17,17 101:13 139:19 148:7 165:12 185:17 188:5 194:15 213:14 301:17 345:10
bases 266:17
bashful 378:19
basic 199:19
basically 32:9 36:7 37:8 40:21 46:17 52:8 67:15 69:11 77:21 98:13 100:2 119:1 120:2,5,19 122:3,9 123:2 126:11,20 127:1,12 129:1 130:19 131:2,16 132:8,13,20 133:3,11 137:6,12 139:5 141:9 143:21 148:13,16 152:8 161:9 215:15 246:7 345:5
basins 84:12
basis 82:7 84:12 85:16 98:5 99:6 222:22 237:1 268:7 287:5
bathing 352:20
bathy 113:9,11,17,18 134:13,18 138:4 142:22 143:7 146:6 158:1 160:13 165:1 176:4 225:10 228:20 254:3,3
bathymetric 3:8 15:17 21:22 49:2 59:6 113:10 116:3 117:13 118:16 128:6 157:5 160:15 176:5,11 179:3 231:9 234:11
bathymetrical 115:17
bathymetry 24:19 48:9 51:13 63:14 71:22 79:13 83:5 85:18 96:18 98:4 99:16 109:16 114:20,22 119:6,18 134:11 144:2,4,4,9 145:4 153:20 154:10 157:16 158:3,4 179:3 184:4 199:20 250:13,13,14 359:14
battery 40:5 115:11,13
battle 63:2 207:16 341:12
Bay 178:20 179:12
Beach 45:21 67:18 87:7 87:16,19 88:4 95:7 177:14 219:12 220:11 224:1 225:12,15 230:10 232:4,8
beam 26:11,11 33:16 33:18 34:8 55:13 116:22 121:2 123:19 124:11 127:8,9,12,14 164:17 259:7,10,16 260:3 291:17
beat 229:21 338:14
beauty 223:16 227:14
becoming 90:4 305:4,8
bed 70:10,18
beds 147:4
beg 300:19
beginning 181:8 262:3 325:6

behalf 276:17 353:17
behavior 25:18 27:9 28:7,10
behaviors 25:20
behemoth 119:17
believe 6:1 97:20 201:20 224:20 232:4 238:18 267:20 290:17 347:1 370:7 373:16
belt 205:10
BEN 2:14
benchmark 333:17 334:9 335:5
beneficial 188:1
benefit 103:4 117:2 125:16 160:3 201:15 369:4 381:3
benefits 15:19 101:19 122:1 125:14,22 167:15 252:8 253:21 302:13 363:10
benefitted 186:15
benefitting 199:11
Benjamin 339:1
Berger 340:5
Bering 184:8
berth 75:12,13 107:16
berthing 86:13,15
berths 103:14 104:21 145:22
best 19:8 53:22 66:17 68:14,15,15 107:9 127:4,5 138:9 140:20 192:4 267:14 268:4,6 280:16 281:2 306:9 307:1,7 317:13 326:13 376:4
best- 303:14
best-available 303:7 322:2 324:19
bet 381:2
better 12:12 36:13 41:11 45:11 64:8 68:7 68:8 73:2 76:10 94:11 94:13 104:16 116:12 122:15 123:18 129:20 130:12,13,15 131:22 132:16 145:9 150:6 151:22 163:7 178:2 185:4 192:1 197:14 224:16 281:3 292:2,9 295:3 309:22 311:8 315:3 321:20 331:3 335:1,2 340:15 356:22 381:22
beware 90:8
beyond 20:13 25:1 52:3 88:3 116:9,12 151:22 182:19 283:1 357:13
BI 224:6
big 18:2 49:8 60:15 73:12 89:19,20,21 90:10 91:3 92:1,19 101:15 124:12,14 162:20 175:16 181:9 181:11,22 200:17 214:16 215:15 257:15 286:22 291:10 306:6 380:1
bigger 32:13 108:13
biggest 58:19 60:17 74:1 133:15 134:2 157:7 171:5 225:13
Bill 4:8,11 190:12 209:15 243:19 244:5 258:10 266:17 335:11 346:21
billions 200:14
bin 222:11
binary 222:22
bit 5:9 9:7 17:19 28:13 37:12 67:6 72:12 95:6 105:18 106:5 107:1 109:19 114:2 117:11 131:15 134:1 136:6 147:8 150:18 151:16 154:8 159:9,12 162:2 174:15 180:6 182:18 183:4 186:18 187:3 188:21 213:13 247:20 273:18,22 279:13 300:19 306:13 325:10 329:10 330:2 331:2 335:17 344:18 347:19 353:6 359:1 361:22 362:15 365:4 370:8
black 130:5 132:9
BLACKWELL 2:3 183:3 183:9 319:9 334:13 334:17,21 353:5,16 353:19 354:13 366:10 372:13
blame 194:8
blanche 292:3
blank 272:16
blessing 310:14,15
blind 24:9 33:10 127:12
Blinding 127:15
blindly 38:8
blips 128:18 130:1
blocked 95:15
blooms 155:21
blowing 26:4
blown 323:22
blowout 30:20
blue 82:3 132:11 148:17
blurred 38:12
board 226:9 262:20 263:14,14 265:5 268:12,14 323:16
boarder 184:10
Boards 263:16
boat 58:17 60:8,19 62:1 62:6 108:14 222:15 238:21 304:1 380:17
boater 60:6 171:10 185:2
boaters 145:22
boating 6:13 60:16,16 61:16 244:1 247:11
boats 7:6 33:6 156:18 380:16
Boeing 215:17 217:9,13
bogged 222:17 330:7
BOLEDOVICH 2:12 271:20 278:12
books 44:22
Booz 221:20,22
border 87:18
bored 210:18
boresighting 165:8
Bosworth 339:8
bottleneck 92:7 106:18
bottlenecks 303:12
bottom 35:7 110:4 122:8 124:10,18,19 125:5 128:14 129:15 130:8,14,22 146:16 148:17 153:12 256:18 275:11,18 286:11
boulders 82:9
bounce 123:15
boundary 104:9 125:4
bow 220:2
box 225:9
boy 23:20 381:6
BP 31:16 33:1,2,22
brackets 232:16
brain 368:3
Branch 2:15,16 199:5
brand 6:1
breadth 186:7
break 32:21 37:7 71:15 110:7,10,12 172:20 189:16 195:15 213:1 298:22
breaking 32:22
breaks 58:4 89:15
Brennan 2:12 4:10 65:2 65:16,20 100:4,7 101:20 102:3 108:16 170:9 190:2 218:18 218:20,21 224:19 231:12,15 232:18,21 233:5,13,19 234:2,22 235:2,4,12,22 236:16 237:12 238:4,7,12,15 238:17 239:8,9,11 252:1 253:2,7,13 276:5,20 277:2,15,19 278:4,6 279:7 291:5 295:20 326:1 371:16 372:4 382:7
Brennan's 289:9
Briana 40:17 69:15
Briana's 41:5 42:16
bridge 20:19 46:14 47:1 238:9
bridges 335:8
brief 16:21 71:15 88:7 88:17 109:18 113:6 113:14 115:7 166:13 167:17 183:17 198:2 210:5 239:13 340:2 364:17
briefing 5:19,19 190:5,6
briefings 167:3 318:9 366:15
briefly 14:17 120:14 181:12 358:17
briefs 113:7
Brigham 1:15 10:5 58:22 105:14 154:17 183:15 185:5 248:17 249:8 251:9 257:20 282:11 296:18 311:10 317:21 337:15,16 338:10,13,16 343:3 349:2,7,16,19,22 351:16 355:22 356:7 364:19 372:20 381:18
bring 5:12 6:4 8:22 15:9 62:5 63:7 64:1 90:12 90:12,22 97:7 104:15 156:18 205:19 212:7 221:10 222:16 248:10 257:2 260:6 267:4,10 270:6 361:17 377:19
bringing 8:15 87:8 275:10
brings 11:3
broad 191:16 207:8
broadband 100:14
broaden 12:6 183:3,5
broader 27:5 71:22 267:19 273:15
broadest 268:7
broken 317:8
brother 224:4
brought 157:13 291:18 296:7 308:9 322:10

361:10 377:3
bubble 25:20 293:19
bubbles 26:4 28:10 32:10,16 140:13
bucket 91:21
budget 2:18 346:3,4 362:13
build 40:13 197:3
building 61:12 93:10 239:19 240:10 241:14 294:7
built 20:16 23:10 73:14 88:5 91:17 96:20 172:17
bulk 80:15,15
bullet 298:10,12 381:6
bummed 186:1
bunch 124:5 144:7 152:21 318:9 321:5 358:13
buoy 46:5
buoy's 46:6
buoyancy 39:6
buoys 47:7
Bureau 92:21
bureaucratic 265:3 379:17 380:2
bureaucratically 380:10
burning 301:8
Bush 72:20
business 13:19 48:14 73:3 76:1,2,3 97:19 97:22 101:2,8 105:8 110:5 127:16 171:2 171:13 175:1 217:6
busy 77:21 92:5 315:8
Butkiewicz 38:14
button 114:10
buy 89:10 240:21
buzz 345:1

C

cable 165:15
cables 79:5 165:13
CAD 77:8,9
cadre 66:6
calamities 92:13
calculate 128:22
calculated 132:11
calculating 128:22
calculation 40:3
calculations 34:13
calendar 230:4
calendars 311:8
calibrate 164:22 165:7
California 28:17 57:15 57:15 254:8 261:2
California's 58:10
call 6:19,20 28:19 30:10 30:11,12 52:4 76:22 77:14 87:12 134:15 173:11 186:12 300:2 301:21 314:14 315:4 316:16,16 353:22 354:4 355:15,16 383:2
called 4:20 25:20 28:22 30:16 69:5 122:20 126:8 169:7 203:22 207:19 215:13 221:19 226:20 250:7 362:5
Callender 2:9 212:14 213:20 333:21
Callender's 301:20 340:8
calls 38:16 41:14 295:5 312:3 332:4 382:21
calm 123:14
camera 118:5,14 119:11 143:2 148:4 149:12
Campbell's 215:18
Canada 58:19,20
Canada/U.S 184:10
Canadian 111:8
Canyon 191:19
cap 30:17 31:6,14 32:8
capabilities 3:9 12:5 79:10 118:7 119:4
capability 199:16
capable 166:10
capacity 92:11 106:15
capped 30:10
caps 264:8
Capt 3:6 65:2,16,20 100:4,7 102:3 108:16 170:9 218:21 224:19 231:12,15 232:18,21 233:5,13,19 234:2,22 235:2,4,12,22 236:16 237:12 238:4,7,12,15 238:17 239:9,11 252:1 253:2,7,13 276:5,20 277:2,15,19 278:4,6 291:5 295:20 326:1 371:16 372:4
captain 1:19 2:12 101:20 107:21 218:18 218:20 220:7,18 239:7 278:21 279:7 306:9 314:8 325:15 382:6
capture 31:4
captures 93:18
card 94:2,4
care 39:16 261:11 266:11 325:16 355:8 381:7
career 5:1
careers 321:6
careful 151:20 171:3 270:15 279:12
carefully 276:22
cargo 74:6,9 95:18
Carnival 325:14
Carol 1:17 3:9,11 15:7 15:16 51:19 52:6 113:12 153:17 154:18 154:21 160:10 165:18 192:5 269:21 286:1,2 359:14
Carol's 110:16 187:22 187:22 280:6 281:15
carried 61:8
carriers 219:16
carry 100:16
cars 37:5,6 73:9 91:5,5 91:6
carte 292:3
cartographic 238:10
cartographically 226:15
cartoons 47:18 48:22
cascade 261:18
case 44:11 45:4 48:10 56:7 61:7 88:4,6 92:8 92:12 94:21 95:5,18 95:20 97:9 101:12 105:16 131:10 147:2 148:7,21 193:22 243:9
cases 11:10 21:10 75:15,18 122:3 144:3
Castle 47:2
catalyst 296:6
catch 56:4,10 211:7
categories 120:3
categorize 268:6
category 120:7 276:15
cats 352:20,20
cause 142:13
caused 123:2
caution 45:6
cautious 242:2 265:3 273:1,18
cautiously 243:1
cavalier 55:3
CCOM 14:21 115:3 173:21 197:4,17 210:8 367:2
CD30 149:12
ceiling 140:8
cells 221:15
Census 92:21
center 2:2,4,6 5:21 6:2 7:18 8:22 10:7,10,14 10:15 12:10 16:22 17:1,20 18:7 114:21 198:12 200:19 203:6 203:7,7 204:4,6,7 323:21 325:13,20
Center/Center 3:5
centimeter 74:6 161:2
centimeters 133:4,4,7 148:22 163:12 192:6 192:6,8 231:20,21 232:5,9
centimeters' 133:8
central 105:16 247:4
centralized 342:21
centric 182:10
century 3:7 106:1
certain 206:12 223:18 248:8 280:14
certainly 19:17 47:14 49:9 51:15 54:12 57:2 102:3,6 116:11,18,20 162:17 169:17 172:22 174:17 180:17 181:7 196:3 216:9 224:7 241:3 242:14 245:7 252:15 253:11 256:2 296:4 303:2 304:10 320:11 321:9,22 371:6 375:14 376:8 376:11
certification 371:19
certifying 153:2
cetera 12:10 75:2,22 76:10 80:11 86:18 88:15 95:4 239:21 241:19 271:9
chain 96:8 184:9 215:13,16 217:1,19
chairing 209:17 311:14
chairman 296:19 343:10
challenge 48:3 105:18 213:14 324:22
challenged 33:8
challenges 73:18 81:7 147:7 151:4 152:9 155:14 158:20 213:19 218:1 240:15 324:20 324:21
challenging 155:13 156:4
chance 70:8 142:12 178:11 217:11 320:18 351:10 357:9
change 22:22 40:7 47:4

47:4 50:12 79:14 97:19 101:15 104:17 109:17 157:3,4,8 160:4,5 162:2 165:14 165:15 174:1 181:22 191:10 192:17 193:12 216:6 254:20 274:20 277:8 371:18
changed 107:1 148:12 272:5 292:1
changer 296:5
changes 6:13 25:2,3 79:14 105:2 147:18 283:16 357:17 358:5 359:3 364:9 366:11
changing 16:19 64:18
channel 52:21 103:15 120:5,9,13,18,22 126:18 127:7,21 128:1 131:14 134:14 134:17 135:3,4,5,6 139:8 141:3,3 146:2 171:14 219:11 220:6 244:9 276:8 316:5
channel's 274:10
channels 52:20 104:22 126:14,20 145:21 165:1,1,2 245:10 246:2,15,18,20 255:6 275:19 278:19 281:11 286:7,18 287:4 288:3 289:4 290:8 297:9 299:19 317:9
charge 265:22 373:17 373:19
charged 362:8
Charleston 285:8
chart 2:17 18:10,13,16 40:13 41:15 42:15,18 43:5,10,17 45:3 48:4 48:14,15 63:17 64:11 64:12,16 65:4 66:13 69:3 71:9 100:11 104:7,7 107:1,3,6,11 108:13,15 171:5 172:14 227:20 229:21 255:22 259:21 261:13 261:14 272:22 273:17 291:15,16 292:13 303:15 316:2,5 325:9 337:6,13,14 342:22
charted 104:11,13 229:14,16 257:7,16 258:14,18,18 259:18 280:8 297:10 299:20
charter 357:8,17 358:6 358:11 359:4 363:6 364:10,20 366:11,17 370:11 371:3 372:7 373:14,22
charting 15:21 42:18 100:9 102:1,11 103:18 104:5 152:19 164:6 169:13,16 172:10,13 176:15 179:19 180:3 198:21 200:19 201:22 203:2 218:2 227:3 230:5 242:15 244:10,17 245:10 246:1,17 254:14 255:5,20,22 256:14 272:21 274:13 276:11 281:10 282:4 282:14 286:5 289:4 299:14 302:22 303:6 305:13 311:17 312:21 314:11 315:10,11,20 324:18 330:4 336:17 340:22 341:3 345:20 347:21 348:1,6,7,17 353:8 355:2 358:15 359:2
charts 10:20 65:12 66:9 66:10,16,16 85:13,19 85:20 86:4 96:18 99:13 161:2 180:1 245:15,17 246:12,14 249:5 255:11 273:5,8 274:12 278:17
chat 350:13
cheaper 73:3 305:9
check 229:19 354:14
chew 379:6
Chief 2:10,12,13,14,16 2:19
Chiroptera 121:11 130:17 132:12 134:12 134:21 146:9
choice 139:12 224:2 259:8 324:12
choir 277:16
choke 8:3
choose 143:15 301:3 382:2
chop 140:15
chose 111:19
Christian 65:17,21
Chu 30:13 33:12
ChUM 41:14
CIQ 224:1,1,4,19 225:2
circle 34:16 331:21
circular 25:19 122:5
circulate 190:15 300:1
cities 73:15 89:5
city 73:14 75:1 87:15 89:5
claim 152:13
claimed 80:6
claiming 152:1
clarification 255:2
clarify 278:13 286:22
clarifying 259:1
clarity 128:3 129:18 135:21 136:13 137:1 147:18 148:2 152:10 155:19
Clark 169:6 239:16
class 121:20 336:5 365:2
classification 149:7
classified 62:13,22 63:3
classify 148:3,12,14 268:6
clear 30:3 124:22 125:3 125:5 128:13,14 129:13 130:7 133:17 149:18 157:18 219:1 246:12 277:5 278:7 317:6 340:15 378:5
clearance 45:6 74:8 84:19 220:12 233:12
clearest 155:18
clearly 30:4,4 130:21 145:19 147:20 279:17 324:15 326:2 350:1
Cleveland 173:4 187:20 194:16 331:16 332:3
clever 35:10
click 22:20 32:6,6,9 41:1,2
clicker 221:13
client 34:4 136:7 137:16 164:2 171:12
clients 154:5 164:3,5 191:17
clique 199:2
close 57:19 64:22 87:18 91:7 94:4 96:19 138:4 140:5 142:15 146:15 154:11
closest 364:7
Closing 3:19
closure 205:20
cloud 140:8,10 143:3 145:1 150:4 158:22
clouds 148:14
clue 280:18
cluttered 233:9
cluttering 235:11
co- 186:22 213:10
co-chair 362:6
Co-Director 2:1,5
CO-OP 176:22
CO-OPS 2:17 141:8 320:1 333:13 336:15
coast 2:8,14,19 5:21 7:4 8:14 10:9 13:18 16:22 27:14 40:18,19 41:12 42:19 52:5 59:1 59:5,10,15 63:18 141:7 153:17 173:11 176:17 184:4,13 249:2 257:22 263:9 271:1 303:20 326:5 365:5
coastal 3:5 36:16,20 50:15 51:22 168:20 203:6,8 233:2
coastline 47:19 158:21
cocktail 219:21
code 222:20
COF 18:10
cognizant 180:9
cohorts 9:20
cold 51:4
Cole 175:21
Colin 21:7,7 44:2 61:3
collaboration 196:22
collaboratively 26:18 354:7
colleagues 64:22 302:8
collect 8:9 92:22 107:18 119:10 158:3 158:4 164:9,18 200:13 254:13 261:12
collected 51:22 70:3 164:7 254:18
collecting 51:11 70:5 119:6 120:17 141:10 142:22 261:6
collision 92:13
Colonel 352:8,9 382:18
color 148:19 149:13,14 222:20
Color-coded 48:13
colorized 143:3 145:3
colors 107:4 234:21
column 25:4,5 27:7,16 35:4,9,17 38:1 39:10 122:10,13 124:2,4 127:21 135:9 138:16 138:20,20 147:11,16 149:19 199:16 201:13 208:10
column-capable 27:11
combination 36:13 228:21
combine 92:16 229:5
combined 169:14 199:17,18 229:10 276:13

come 6:10 7:7 11:6 17:6,20 18:20 22:4 26:5,7 30:5 36:6 43:1 45:1 51:16 69:15 85:16 111:4 112:17 113:17 128:17 140:6 160:14 168:16 193:8 194:13 209:7 218:9 224:21 229:2 240:17 242:8 250:20 251:18 257:12 264:1 265:12 270:10 271:11 282:9 297:13 299:16 309:10 314:9 329:14 340:20 351:12 362:20 378:2 381:2
comes 52:15 59:13 62:21 66:18 88:22 93:3 103:20 123:19 172:5 194:10 198:10 202:15 216:17 222:10 234:20 249:18 270:16 287:11 288:7 297:18 306:16
comfort 153:11
comfortable 18:4 278:22 279:5,6
coming 17:9 25:7 27:12 27:19 28:17 31:10,14 32:16 47:1 52:12 58:6 63:15,16 65:18 83:10 91:6,6 105:7 123:8,10 129:19 150:2 161:9 161:15 171:1 181:17 182:5 240:3 253:8 268:1 270:15 275:8 331:17 333:9 353:4 372:16 379:9
command 6:1 10:7,10 10:14,15 12:9
commander 29:12
commanding 7:3
comment 3:12 9:4 10:14 51:7 58:14 63:6 90:7 96:22 109:21 114:12 154:18 166:3 166:4 167:4 169:20 169:21 178:7,22 191:6 192:19 193:19 197:21 202:21 207:20 209:11 237:6 245:11 246:2,3 249:16 254:22 256:9,17 269:9 271:16 272:14 276:6 281:15 289:9 291:6 296:20 310:5 313:21 314:3 325:11 335:13,14 337:9 338:6 342:19 344:13 345:15 346:12 347:9 347:11 348:14,22 352:21 353:13 355:22 356:16 358:21 366:16 367:1,16 371:5,15 374:16,18,22 375:18 379:3 381:14
commented 202:22
commenting 237:8 279:3 281:5 321:22
comments 7:3 12:15 50:3 51:17 61:21 65:19 79:13 98:2,15 102:2 110:9,17 112:14 189:9,10 192:18 207:22 209:4 215:3 244:2 245:8 246:1 272:5 293:4 302:4,21 304:1 308:21 332:20 336:2 340:21 341:17 342:10 344:7 346:9 348:5,13 353:8 354:1,9,12 355:4,6 357:7,8 359:21 363:6 366:12 370:11 371:2 372:6,8 372:19 373:14 375:14
commerce 1:1 215:14 297:10
commercial 7:21 58:15 171:6 174:20 175:19 175:19 275:20 286:7 288:2
commissioned 239:14 276:15
Commissioner 365:13
committed 219:7
committee 4:7 6:22 261:3 264:2 267:18 293:19 295:6 360:6 361:8 362:7 377:16
committees 270:2 355:20
common 75:9 120:20 160:12 253:9,19,22
communicate 75:16,21
communicated 332:12
communication 186:18
communications 173:14 175:12 241:22
communities 160:14
community 5:1 39:20 41:12 58:20 62:13 335:7
companies 198:14,14 200:12 268:1
company 4:20 152:18 174:20 226:19
compare 84:19 116:14 229:13
comparing 164:11
comparison 129:9 229:12
compete 217:6
competent 350:5
competitive 76:2
Competitiveness 215:13
compilation 227:20
compiled 63:18 354:2
complete 48:12 300:20 331:21
completed 17:22 252:10
completely 54:11 68:22 100:4,7 134:18 207:10 222:17 332:2 350:21
completely-- 359:11
complex 123:21,22 124:8 154:12 156:17
complexity 105:15 106:10 154:20
compliance 237:11
complications 142:3
component 18:12 43:19,19 371:22
components 44:4
computationally 223:1
computer 18:20 39:13 60:9 66:21 70:6
conceivable 256:2
concentrate 103:13
concentrated 176:17
concept 45:20 46:3 80:1 211:19 250:9 303:6 307:14 320:12 324:19
concepts 115:16
concern 203:10 241:3 267:1,16 268:16
concerned 186:9 356:12
concerns 117:3
concerted 108:17
concise 68:3
conclude 215:5
concluded 22:3
conclusion 89:1 214:20 270:15
conclusions 376:6
concurrent 240:1
concurs 363:7
condense 370:22
condition 23:15
conditioner 139:7,11
conditions 23:6 47:5 86:16,18
conduct 264:21
conducted 252:3
conference 108:21 111:7 228:18 315:4 354:4
confidence 161:6,8 163:13 325:14
confident 156:19 163:11
configured 81:15
confirm 229:14
conflicts 248:9
confused 353:6
confusing 226:7,14
congestion 95:10 304:5
congratulate 213:7
congratulations 383:19
Congress 198:7 199:4 240:8
congressional 365:9 372:21 373:4,6
congressman 373:1,2
congressmen 373:7
conjunction 153:22
connect 88:2 104:16 197:1,10,14 201:11
connected 17:15 91:5 183:12 196:14 197:11 334:21
connecting 81:12
connection 100:15 197:6
connections 106:4
connectivity 201:19
connector 103:14
connects 200:20
consensus 254:9 264:17 275:7 324:17 348:9 381:22
Conservancy 253:4 261:9
conservative 34:15
consider 205:1 209:20 251:8 337:11
considerations 141:1 142:10 305:2
considered 296:11
consistent 116:3 246:18 247:2 250:10 250:22 251:1,2 289:5
consistently 292:6
consisting 193:15
constant 104:20 105:2
constantly 19:11
Constituent 78:9

constraints 54:17 305:1
construction 17:19 20:20,21 76:18 82:15 83:22 84:2 104:2,3 246:14 257:5
consult 54:2,8
consultant 242:7
consultations 265:10
consumption 232:2
contact 170:5 263:2,3,4 263:7,8,13
container 80:13 106:14 235:16,17
contended 55:16
content 293:22
CONTENTS 3:1
context 17:1 48:20 49:6 91:4 293:8,22 327:22 329:11 351:8 360:16
continue 71:18 180:19 189:2,15 209:6 214:11 231:10 316:15 375:21
continued 213:7
continuously 324:14
contour 226:3 227:16 227:22 231:14 232:7 232:9 233:3 234:18 234:19 237:21 238:21 239:1
contours 8:4 43:14 223:4,5,10,12 226:1 226:14 227:5,18 228:5,8 231:4
contract 77:7 81:11 178:18 240:22 274:14
contracting 81:17 198:14
contractor 12:19
contractors 70:5 172:6 274:15
contracts 208:8
contradictory 317:17
contribute 96:16 166:20,22 167:11,21 318:11
contribution 169:11
contributions 41:5 337:20
control 56:18 74:14 100:17,20 165:5,7 172:4 201:16,17 323:21 333:3
controlled 236:2
controller 134:22
controlling 103:17
controversial 42:22
convening 6:22 383:2
conversation 256:7 259:1 293:9 313:9,10 351:1,20
conversations 102:14 207:2,5 244:20,22 293:13 294:4 304:4 323:19 329:9 351:9
convert 97:15 205:22
cool 8:8 145:13 146:3 187:2 213:8 359:8
cooperation 41:11
coordinate 341:10
coordinated 350:10
Coordinator 2:16
copious 194:10
copy 59:1
core 77:1 89:2 345:17
corn 221:2
corner 91:16 146:16
corporately 327:1
Corps 52:20,22 112:2 114:19 119:15 192:14 229:3 230:13 244:10 244:14 247:3 249:4 250:9 259:3 262:10 263:7 270:4,22 274:18,20 275:12 276:8 277:3 278:19 281:22 285:6 286:10 287:3 292:2,4,8 296:2 297:17
Corps' 259:8
Corps-NOAA 279:3
corral 146:2 187:16
correct 69:2 102:7 147:14,20 228:6 229:6,11 259:21 272:8
corrected 158:15,16
correlation 243:13
corridor 115:20,21 233:10,18,18 234:18
cost 139:12
costs 95:3 217:7 249:9
Council 248:19 362:6
count 56:3 92:8,10
counterparts 242:21
counting 157:14
country 7:6 100:8 249:1 283:21 304:22 338:4
counts 55:20
couple 11:6 13:16 28:17 63:7 79:12 87:2 87:11 113:16 144:13 156:10 164:7 173:9 183:16 198:6 205:5 215:10 222:14 231:15 232:13 258:11 270:21 270:21 300:2 302:20 304:3 331:19 335:18 348:1 350:12 356:8 356:18 365:11 370:6 373:13 375:11 378:15 383:7
course 11:1 16:5 66:1 74:3 76:1 83:4 94:20 149:3 185:5 255:20 301:10 312:3 318:14 322:6 339:1 381:16
court 372:21,22 373:6
cover 158:22 214:22
coverage 43:9 51:11 145:6,10 153:6 246:21 275:18 290:9
covered 180:5 266:17
covers 10:10
coxswains 62:1
crab 139:15
crabbing 139:14
craft 265:9 308:18
crap 295:13
crashes 36:21
crazy 62:4
create 40:18 77:13 93:17 94:1 122:5 226:22 230:22
created 40:20 67:12 81:2 87:2 149:17 178:14 221:20 226:1
creating 12:1
crew 241:16
crews 29:16
critical 11:10 22:1 94:21 242:22 252:18 275:19 281:10 282:5 286:7,13 288:2 290:18,18 291:19 297:10 311:22 314:5 317:9 371:13
CROCKER 2:13
cross 57:2 148:15 242:19 255:3 258:2
crossed 149:17
crossline 191:12
crowdsource 11:22
crowdsourced 229:2
crowdsourcing 96:18 325:8
crude 219:16 221:7
cruise 10:15 64:9 70:16 70:16 173:19 315:18 325:14 364:2
CSDL 210:8
CTDs 29:17 38:8
curiosity 149:22
curious 60:4,11 341:11
current 21:15 22:4 37:21 38:1,6,19 40:4 40:5 44:6 69:17 80:5 120:1,2 138:18 174:14 179:19 243:13 319:2
currently 133:16 229:14,16 230:1 240:16 242:1 246:13 328:21
currents 9:1 23:6 24:7 24:13 44:1 63:21 138:12 155:9
curve 83:1
customer 170:21 217:3
customers 74:16 76:5 171:3,5 184:19
cutting 231:3 358:19
cyan 148:19
Czech 95:21
CZMIL 119:13 120:14 126:1,6 129:10,16,20 130:6 133:16

D

D 64:17 196:17,17,19
D-square 160:18
D-Y-E 38:18
dah 345:8,8,8
daily 50:12 85:16 88:6 98:5,21 99:6
Danes 227:15
dangerous 32:11 40:11
dark 136:17,18 148:17 150:21
darker 147:13
Dasler 110:19,21,21 131:17 191:5 208:2 291:6,9
data's 51:20 281:3
data- 182:9
data.gov 72:21
database 41:6,7,8 94:3 175:20,22 176:1,4,5 176:11,11 225:10 228:20 231:9
database-driven 22:19 176:10
databases 64:6 81:4 176:8
dataset 254:17
datasets 250:18
date 79:16 86:3 115:6 225:3 274:8
dated 271:21
datum 10:2 14:1 119:6 119:7 133:12 141:5

141:12 161:17,19,22 359:10 372:11,15
datums 9:8,16 133:12 141:20,22 164:18 364:11,11 372:13 383:8,10
Dave 6:16 110:21 160:8 160:9 189:11,13 193:16 206:22 243:15 248:2 249:14 252:2 252:21 253:16 254:10 269:8 279:20 294:3 312:19 313:1,6 342:8 351:2 352:5,7 376:12
Dave's 163:18
David 1:18 178:20 202:14
dawned 351:14
day 3:2,19 4:4 9:13 15:20 34:18 48:11 51:7 73:9 77:21 85:20 91:19 140:16 147:20 175:14 181:13 233:16 264:3 265:20 288:19 320:10 357:12,13 367:5 368:9 370:13
days 4:18 13:16 155:20 173:15 347:3
days' 299:8
de 62:20 102:5 142:19 150:3
deadline 6:20 341:3
deal 66:19 67:6 93:9 100:8 200:17 214:1 244:18 380:4
dealing 66:4 136:16 311:15
dealt 173:10 196:17
debate 119:21
Debow 26:8 64:20,20 65:3
Debow's 337:9
decade 120:10 132:2 150:7 159:13 163:1
decades 10:13
decent 92:17
decide 135:15 181:6 214:5,9 269:15 294:15 363:22 368:2
decided 5:2 6:8 17:5 244:21 245:3
decides 87:15,16 282:6
deciding 84:22 270:22
decimated 222:10
decision 260:21 261:1
decision-makers 36:20 382:13
decisions 73:1 75:9 78:15 80:17 94:9,10 94:14 101:2 175:1 182:5 248:11 296:9 296:11
deconflict 287:14
decreased 118:2
dedicated 13:5 109:8 118:3
deemed 242:17
deep 29:6,10,20 37:12 38:7 75:13 83:12,17 84:3 120:5,6,9,13,17 120:22 126:18 127:7 127:21,21,22 131:14 134:6,14,16 135:3,4,5 135:5,8 138:5 139:8 141:2 200:9 250:13
deepening 79:2,4
deeper 103:5 126:18 130:14 147:12 152:4 229:21
deepest 83:13
deeply 15:6
deepwater 27:10 28:18 28:19 38:4
defenders 82:8
defer 278:21 279:7,12
deferring 356:20
define 233:10 379:19
defined 227:3 256:5 363:15
defines 225:9
definitely 62:9 105:10 155:13 156:4 159:17 348:10 372:15
definition 50:11 143:5
deflect 219:22
deflection 220:2
defy 348:11
degradation 82:22
degrade 43:15
degree 20:14 33:17 48:12 65:1 82:5 92:17 220:1
Delaware 37:5
delegations 365:10 373:4
deliberate 353:12
deliberation 350:20
deliberations 4:14
delineated 148:11
deliver 100:11
deliverables 35:21 208:5
demand 70:12 108:6 294:2
demonstrated 31:19
demonstration 146:8
DEN 2:19
Denmark 226:20
dense 116:16,18 151:5
denser 118:10 119:3 120:16 121:5 131:13 152:6,11,16
densities 116:15
density 92:4 126:5,17 127:2 157:9
depart 365:1
department 1:1 72:18 81:16,17,18 103:17 215:14
departments 75:17,18 75:20 80:22
depend 165:4 273:9
dependent 133:10 160:22,22 161:10
depending 128:2,3 151:13 238:20 364:12
depends 136:12,14
depict 21:13 36:13
depicting 28:9,9
depiction 28:16 51:2 52:21
depicts 30:8
depletes 31:1
depleting 147:5
depth 18:9 25:14 35:5 37:9 84:15,15,20 107:12,12,15 116:1,8 116:13,16 128:12,22 129:1,4,18 133:5,10 136:1,4,6,10,12,21 137:5,6,10,11,12,15 137:16,20 146:17,19 148:2 151:17 157:19 158:17 160:22,22 219:12 220:6,19 223:13,18 226:2,3 234:20
depths 35:11,18 105:2 135:22 141:4 158:8 222:20 250:12 251:4
Deputy 2:15 4:10
derived 179:2
derives 199:14
describe 125:15 200:10
description 41:3
deserve 376:13
deserves 382:19
design 80:1 134:10 157:10
Designated 2:7
designed 67:12 80:12
designing 80:2 184:2
desirable 100:21
destruction 55:1
detail 145:11,15,16,16 150:5 154:13 319:18
detailed 22:21 226:6 245:16
details 142:13 146:2 207:4 321:18 339:2
detect 130:14 149:1 150:21 249:12
detected 291:20 292:12
detecting 153:2
detection 116:12 117:16,17 126:8 150:10,18 151:1,18 152:2,7,21 153:1,5 199:16 200:4,4,6 208:3,7,10 246:21 260:3 275:18 278:1 289:11 290:9,17 291:20 297:12 299:21
detectors 140:7
determine 58:3 153:19 269:13 279:21 281:17 282:8
develop 19:3 39:15,18 46:11 47:9 141:20,21 162:18 197:4 242:8 290:21 291:2 328:18 354:8
developed 25:5 27:8 38:14 59:7 83:18 164:14 279:1 340:14
developers 24:20
developing 129:6 186:16
development 2:20 44:18 74:16 94:16 225:5 277:13
developments 190:6
develops 39:22
device 20:16 46:5 88:14 98:14
devices 46:3
devolve 133:1
Dewberry 252:3
DFO 4:10 328:4 354:18 355:16 370:19
dialogue 340:14,16 375:22
Diane 374:14
dichotomy 50:9
Dickie 174:7
Diego 4:21
difference 8:13 63:15 131:7 276:7 300:18 330:3
differences 125:8 244:9
different 8:20 12:22 13:8,8 15:16 17:3

18:6 21:20 38:20 40:1 42:1 53:3 56:22 62:7 64:8 68:1,1,17,22 72:5,5 73:5 74:22 75:3,20 76:5 80:22 81:12,18,19,20 82:1 83:3 86:16 87:6,21 88:11,11 90:9 91:4 92:22 100:5,8 104:20 104:22 105:1,12 111:12 124:9 125:9 126:2,13,14 134:9 135:10 144:19 147:19 174:21 184:22 206:18 207:7 211:22 214:12 218:10 224:3 226:17 227:6 231:16 237:2 238:8 246:7 256:7 258:6,7,7 259:6 268:5 269:6 276:14 278:20 280:21 283:14,17 312:11 316:17 321:12 330:11 378:6
differently 5:9 127:1 218:4 318:8
difficult 49:4 51:15 149:1 163:22 315:3
diffuse 138:2
digital 22:19 40:18 41:8 41:18,18 60:13 148:4 249:19,19,21 255:21
digitalization 107:6
dimensional 71:7
dimensions 40:22
diminished 23:11
dipole 38:17
direct 20:9 35:1 243:13
directed 186:19
direction 67:1 68:22 103:8 139:19 371:20
directions 143:10 144:19 203:2 256:8
directives 369:5
directly 82:18 99:9 171:11 291:14 304:8 364:14
director 2:3,4,8,12 5:17 21:8 329:5
directors 14:21 29:8
disagree 19:13 251:18
disagreed 310:9
disagreement 19:16
disaster 87:10
disburse 240:9
disc 137:7
discern 128:19 130:1
discipline 242:19
disconnect 186:21
discover 94:7
discoveries 198:17 199:9,12
discovery 198:9 199:15 200:16
discredit 33:2
discrepancies 348:7
discrimination 128:6
discuss 6:14 16:11 17:4 122:1 125:22 167:13 168:7 180:22 187:7 190:1 193:7 214:10,21 282:16 295:12 310:6 323:6 336:1 366:21 381:21
discussed 14:22 15:5 120:15 291:10 371:10
discussing 245:6 247:20 257:1 281:12
discussion 3:2,11,13 3:15,18 14:10 16:1,2 16:5,7 18:16 20:11 49:18 71:12,19 90:3 104:17 110:14 176:8 189:3,6 190:10,15,17 195:11,14 196:1 197:22 210:1,1,5 213:8,15,15 215:7 216:12 218:22 248:16 255:3,19 257:21 259:9,16 260:11 266:18 294:8 296:7 297:5 308:11 310:11 319:17 322:18 323:16 324:13 325:9 350:9 354:16 369:2 371:8 374:15 379:11 381:10 382:10
discussions 13:15 18:15 113:6 170:3 187:14 190:11 217:19 236:20 247:15 265:15 293:18 294:13,18 295:4 300:14 303:18 322:17 325:6 350:20
disingenuous 356:5
Disney 217:15
disparate 111:4 325:1
display 20:15 22:7,22 23:7,13 24:8,12,20 44:20 48:8 49:15 61:7 62:3,3 68:15 70:17 82:2 135:1 184:15 232:17 235:14
displayable 41:20
displayed 44:1 107:2 236:2
displays 44:21 69:18
dissimilar 246:6 247:18
distant 368:1
distinct 276:7
distinction 277:4
distinguish 76:6 77:15
distinguishing 83:11
distracted 60:16 61:16
distributed 42:9 99:18 100:3 299:18
distribution 99:11 102:1 240:7
distributor 171:15
diver 82:20
diverge 127:11
divergence 127:8,9,14
divergency 121:2
diverse 11:19 105:19
diversity 13:7
division 2:10,13,14,17 2:17 42:15 230:5 291:15
do-outs 375:2
doable 341:1
doc 354:7
document 40:19 77:7 247:17 255:4 326:7 344:15
documentation 378:1
documenting 360:5
documents 81:11,13 281:1,1 303:3 312:21 340:18 341:1 347:14 348:5
dog 329:3
doing 7:21 9:11 12:9 17:9 20:3 22:2 23:5 31:18,19 39:19 46:1 54:20 61:3,15 84:7 97:9 100:2 104:11 111:9 112:5 113:11 114:21 116:11,22 122:1 131:20 142:4 147:7 152:2,18,19 153:1,4 154:11 164:5 167:6 168:9 170:19 173:7,18 174:5,13 175:22 188:16 192:14 200:1 202:13 208:9 211:22 212:3,9,20 213:12 214:17 217:6 218:4,4 222:21 225:4 227:9 228:11,12 237:9 254:15 257:22 258:7 270:1 276:3 279:11 283:8,10,19 286:6 288:8 293:18 293:19 309:15 310:19 310:20 315:2 326:14 329:2 332:17 349:10 351:19 353:9 355:11 355:12 358:13 363:11 369:8
dollar 20:21
dollars 34:7 200:12,14 200:14 217:16,17,17 221:5,7,8 243:12,12 296:15
dots 82:2 200:21 201:11
doubled 121:20
doubling 73:21 95:2
doubt 203:19 298:7
download 90:6,16
downtown 6:2
dozen 228:12 381:2
Dr 1:15,18 2:5 3:6 9:12 16:13 21:3 23:17,20 24:5 26:9,22 27:3 32:18 34:6 35:22 36:5 36:12 37:11 42:20 44:16 45:17,22 48:2 50:4,19 51:9 52:10 53:2,18 54:14 56:17 56:21 58:18 61:2,18 62:9 69:2 71:4 98:3 98:10 99:1 204:15 212:14 213:20 239:16 255:1,8,15,18 262:19 264:11,14 297:4,21 298:3,9,14,20 301:20 324:5 331:4 333:21 337:15 340:7 371:2 372:2 381:18
draft 167:14 198:1 214:20 215:1 220:5,8 221:1,5,7 222:21 233:11 238:22 263:21
drafted 300:7 326:10
drafting 214:17
drafts 245:6
drag 40:6
draw 92:9 213:17
drawing 104:8
drawings 77:9 81:13
dredge 84:3,22 85:3,6 85:10 258:15
dredged 104:21 105:1
dredgers 192:14 380:14
dredges 258:13,18
dredging 14:6 83:7 84:10,11 85:2,5,9,10 100:19 102:21 103:13 103:19 104:3,9 216:10 257:6
drifts 27:4

drive 62:4,7 73:1 91:9 110:4 181:9 217:18 314:22
drivel 305:16
driven 67:10 85:8 93:18 101:14 106:8 175:6 175:18 182:1 185:1 350:5
driver 181:11
drivers 62:1 76:12 97:12,13,17,22
drives 216:5,6,7
driving 103:8 175:1,18 202:17 210:21 215:16
drones 4:21
drop 138:15 166:12 230:17
drove 101:2
dry 80:15
DTM 222:19
DTMs 66:10
due 341:19
dumbly 139:20
duties 218:1
dye 38:16,18,19
dynamic 177:6 238:1

E

E 1:15
e-navigation 111:7
E.J 2:19 172:19,22 210:7,8
earlier 9:6 151:21 157:12 167:9 176:17 199:15 201:8 202:14 351:7 360:20 367:20 377:4
early 24:20,20 110:12 175:1 205:20 215:22 221:17 226:20 340:17 348:5 369:18,19
easier 130:2 136:22 210:19
easily 41:8,19,19 141:12 198:17 230:17 261:15,15 307:8 329:2 340:11 348:2
east 52:5 73:13
Eastern 309:2
easy 23:22 47:15 70:1 153:13 156:6 168:17 211:6 247:12 377:13
EC 196:16
ECDIS 64:17 66:1 99:4 99:5,10 108:13 171:7 196:14 233:2,10 234:2 235:13,19,20 237:20 238:12 257:22 315:12,13,21
echo 11:17 323:12
echosound 55:13
echosounders 29:18
economic 160:2 252:7 252:7
economy 183:1 215:17 316:19
ecosystem 103:1
ECS 68:11 108:6 197:20
Ed 3:3,14 12:18 13:1 28:14 30:5 50:6 64:9 102:7 132:3 154:17 156:6 167:13,19 173:16 178:22 190:19 196:9 198:2 212:5 218:19 267:6 294:6 304:12 309:14 310:20 368:15
Ed's 64:21 208:2
edge 358:19
edit 271:22 351:7 354:7 360:18
editing 207:3 293:21 377:18
educate 60:6
education 60:5 371:13 374:13
educational 371:22
EDWARD 1:17,19
EDWING 2:4 307:21 308:7 362:3
eelgrass 194:21 195:1
effect 111:5
effected 147:16
effective 21:17 139:16 350:3
effectively 75:16 309:13
effects 139:5
efficiencies 156:9
efficiency 40:7 75:9 94:19 105:8 106:9 344:22
efficient 101:9 116:2,5 116:10,17 179:6,9 223:1 305:9 340:8
effort 10:22 24:22 29:15 108:18 135:9 219:3 220:13 228:5 383:19
efforts 24:17 51:10 52:13 270:16
eight 30:14,16 91:18 146:11,17 192:8 239:1
either 5:12 79:7 110:18 132:12 211:13 212:20 289:18 311:2,4 363:2 372:22
EK60 26:9,9
EK60s 55:14
EK80 26:12
elastic 123:4
electronic 59:5,14 64:16 107:2 184:3,13 350:10 365:5
electronically 88:13 350:8
electronics 134:22
element 60:11 318:18
elements 83:11 100:20 106:10 184:3 242:3
elevated 246:11
elevation 82:12 143:4 163:11 249:20,21,22 250:11 251:3
eliminated 260:19
eliminating 151:10
ellipsoid 119:9 141:10 141:21 161:17 164:10
elliptical 125:10,12 126:6 143:9,19 144:13
else's 244:18
Elwha 142:18 143:9 150:2
email 77:11 332:7 361:18
emails 185:21 193:21 194:5,13 315:3
embark 220:11
embedded 177:2
emerging 197:16 362:17
emphasize 199:1 201:21 212:8 320:16
empirical 163:2
empirically 132:4 163:3
employing 153:19
empower 381:8
empties 142:18
empty 80:9
enable 77:17 78:15
ENC 86:5 108:15 179:21 182:18 224:7 235:6,9 238:21
encompass 290:11,13
encourage 197:12 214:1 306:14
encouraged 231:6
encouraging 230:10
ENCs 99:17
ended 220:2
endorse 204:3 212:19
endorsed 250:9 310:11
endorsing 203:5,8 204:6,6 212:15
ends 306:19
enemy 326:16
energy 30:13 39:19 123:6 124:15 127:19
enforcement 75:2 87:10
engage 323:2
engaged 318:8 356:10
engagement 3:16 78:9 170:21 187:8 193:3,5 193:15,20 270:9 291:3 308:22 312:1,2 321:15 323:5 350:2 353:22
engineering 17:14 77:8 81:13 374:15
Engineers 52:20 114:19 229:3 247:4 249:4 250:9 263:8 275:12 296:2
English 114:6
enhance 179:5 183:20 185:13
enhanced 23:5 24:6,13
enhancing 59:19
enjoy 307:21 368:12
enjoyed 9:7 368:15
enjoying 306:4
enlightening 365:14
ensign 66:21
ensigns 66:5,6
ensure 8:5 297:9 299:19 306:17,20,22
ensuring 227:20 235:6 362:9
entering 74:10
enterprise 76:9 77:6,10 77:12 81:3
enters 124:11
entire 77:17,21 100:17 102:22 198:11 252:4 254:17 275:22 317:4 349:19 350:18 356:4
entirely 102:20 287:18
entity 107:9 262:16
entry 86:15
environment 41:18 49:10 88:16 93:17 117:1 139:1 151:19 155:13 156:5 243:14 316:20
environmental 10:12 59:20 185:13 303:20
environmentally 117:9
environments 117:8 154:12

epochs 364:12,12
equates 309:3
equation 133:9
equipment 380:16
equivalence 160:15
equivalent 250:16
era 255:21 315:10
erode 37:7
erosion 36:17,18
error 132:20 133:9,10 133:11 161:22
errors 161:16
esoteric 228:2 236:19
especially 10:1 84:3 106:11 124:22 142:4 178:11 187:4 303:8 320:10 377:18
Esri 2:22 72:1 97:9
essential 8:18 105:17 294:13
essentially 58:16 74:4 76:21 134:16 147:13 148:17,19 255:14
establish 76:22 107:8 232:16 241:18 246:19 247:2 253:19 269:12 290:4 297:8 299:18 342:19 346:14 377:7
established 77:4 310:18 339:20 347:1
establishing 268:10 336:5
estimate 203:20
estimates 55:18
et 12:10 75:2,21 76:9 80:11 86:18 88:15 95:4 239:21 241:19 271:8
Europe 73:8 76:3 102:4
European 96:3,4
evaluate 94:11
evaluated 255:10
Evans 2:14 110:22
evening 299:7
event 17:10 87:12 272:11
events 88:18,20
eventually 17:7 142:14 159:8 245:3
Everett 4:12
everybody 20:7 31:12 57:17 70:13 101:7 112:1,3 127:12 168:15,18 171:4 183:11 186:5 190:13 192:13 193:5,8,10,10 193:22,22 208:3 210:11,20 216:22 244:18 253:6 254:10 261:17 293:2 297:7 298:18 302:4 306:7,7 306:21 309:5,21 312:3 314:16 316:10 333:5 341:1 349:10 361:12 372:8 375:3 383:16
everybody's 58:11 294:19
evolution 103:3 174:3 312:6
evolutionary 69:5,10
evolved 245:2 311:13
evolving 20:1 327:16
ex-students 29:13
exact 319:22
exactly 36:5 51:7 57:14 66:15,16 100:13 123:9 129:17 234:15 237:12 258:20 375:1
examine 294:10
example 20:22 74:5 77:19 79:1 81:5,6 88:17 95:12 130:16 142:16 143:8 144:5 149:12 191:18 192:3 197:7 199:13 203:12 246:22 254:4 290:10 309:14
examples 87:11 125:16 366:3
exceed 220:6
excellent 232:12 323:14
exchange 247:2 365:20
excited 17:12 70:22 123:3 242:14 303:9
excitement 159:21
exciting 13:6 60:4 61:19 67:8,17 221:11 228:13 379:10
exclusion 303:20 304:1
exclusions 303:19
excuse 24:5 33:22 207:18
executive 199:4 329:5 370:18
exercises 37:20
exist 50:17 141:16 161:16
existing 307:9
exists 41:6 51:14,16,17 93:15 161:22 354:12
exiting 74:10
expand 188:21 207:14
expanse 116:6
expansion 204:1 253:14
expect 274:20 347:19 379:8
expectations 326:3
expected 132:17 135:22 136:4 141:4 309:21
experience 15:10 103:22 131:21
experienced 62:1
experiment 33:5 177:13
expert 15:18 62:16 113:13
expertise 114:21 270:6 365:3 375:20
experts 239:15 248:11 251:13 271:8 329:1 375:14
expiration 261:17
expire 81:10
explain 114:4 121:15
explained 212:1 298:10 331:6
explaining 297:20
explanation 113:21
exploration 200:8
Explorer 27:12
exposed 97:8 208:17
express 317:2
expressed 203:10
expresses 314:15
extends 322:12
extensively 156:16
extent 102:19
external 78:10 244:12 244:13 251:20 270:6 343:20 344:3
externally 246:13
extra 29:19 195:20
extract 92:2 227:5
extracting 41:16
extraction 33:7
eye 61:5 68:6 127:15 137:13 224:15

F

FACA 331:6 355:13
FACAs 382:11
facilities 357:13
facility 217:10
fact 13:20 59:16 63:1 67:19 94:2 111:8 199:1,11 203:14 204:7 212:6 215:2 240:16 249:1,17 261:11 274:11
facto 102:5
factor 153:11
factors 60:11
failure 60:21 162:15
fairly 92:17 114:5 131:7 149:7 159:11 220:17 221:21 326:10 327:13
fallen 144:6
falling 199:14 381:17
familiar 160:19
family 217:15
fan 203:17 270:3
fancy 107:5
fantastic 38:5
far 43:5 69:7,7 80:8 95:22 114:8,8 123:10 132:16 150:6 156:10 167:16 223:21 238:9 242:16 245:22 252:7 267:13 268:9,12 304:20 322:12 358:8 363:6
farther 329:8
fascinating 358:18
fashion 252:17
fast 12:6 68:9 91:4,7 119:2 131:12 268:2 302:10
faster 73:2 75:9 94:9 109:7,8 118:8 126:5 127:6 131:9 157:11
fault 27:20 28:3 107:12 185:22 329:7
fav 374:5
favorite 215:21
feature 27:15 41:1 172:11 223:15
features 22:13 40:22 70:19 191:10 192:16
February 245:19 271:22
federal 2:8 87:9 96:15 104:22 248:5 252:19 253:5 274:11 341:14
federally 246:14,20 276:8
federally-maintained 290:7
feed 26:18
feedback 20:7 45:12 202:20 224:12,14 229:18 360:18 363:12 375:5 379:6
feeder 17:16
feeding 25:20 26:2
feeds 84:18
feel 43:11 66:3 159:8,20 166:21 178:17 185:17 202:17 314:21 315:2 333:13 351:5

feels 383:9
feet 58:4 219:12,13,17 220:3,5,5,9,19 238:22 239:1,1
felt 159:13
female 26:16 342:11
fenders 82:16
fiber 165:14
fiberoptic 165:12
fidelity 53:5 339:17
fiducial 191:9,21 192:9
field 2:16 30:22 44:6 67:14 78:15,16 88:13 126:17 160:2 200:16
Fifteen 195:8
fifth 72:16
fight 40:4
figure 19:5 136:9 137:18 138:8 140:19 213:21 243:22 271:12 288:11
figured 29:6 83:19 140:21 226:5
figuring 359:22
files 90:16
fill 172:9
filled 269:18
filming 29:3
final 4:13 42:21 202:5 213:6 214:19 259:17 310:3,15 325:11 346:22 354:17
finalize 315:6
finalized 145:1 196:6
finalizing 83:22
finally 32:2 37:14 47:21 48:3 58:3 64:14 92:19 149:10 150:1 179:16 197:21 214:16
financial 201:14
find 12:12 14:12 21:12 25:21 29:9 33:8,18,19 34:16 38:8 52:16 54:22 55:5 56:9 175:10 179:9 211:5 262:5 295:3 305:11 315:11 340:11 374:20
finder 172:11
finding 57:18 71:3 217:4 260:16
fine 34:16 95:1 211:2 307:17 311:4 357:17 371:3
finish 113:2 166:5 195:9,10,14 196:11 335:11 349:17
finished 104:10 332:13
fire 118:8 127:2,6 131:10 140:10 157:10
fired 127:11
fires 126:4
firing 118:22 119:2 122:4 131:9,12 265:15
first 5:7 13:21 26:14 27:10 28:16 30:8 31:5 38:21 53:19 54:19 55:11 62:12,12 121:9 135:14 142:11 160:6 160:9 166:7 168:1,22 169:5 179:21 191:2 204:12 209:8 215:22 216:19 227:17 233:8 240:9 244:8 245:9 248:14 254:6 256:13 258:12 271:21 275:3 290:19 310:21 320:10 321:8 322:3 327:11 327:14 341:8 342:18 344:15 345:7 348:14 356:21,22 362:17 368:9
fish 25:21 26:4 27:8 54:20,22 55:1,12,17 55:19 56:1 57:20 153:8 351:5
fisheries 26:10 27:9 29:17,18 54:19 56:3 242:21 261:15 303:22
fisherman 58:13
fishermen 55:16 57:20
fishery 25:22
fishing 55:9 57:19 58:15,16,20
fit 149:8 162:14 329:13
fits 176:9 300:14
five 31:5 116:15 133:4,7 161:1,7 192:6 195:22 219:8 222:11 238:22 246:22 254:9 260:22 289:3,18 290:10 291:1 329:12 361:5
five-minute 190:6
fix 264:20 293:11,12
fixed 95:15 270:7
fixes 65:13
flange 32:14
flash 225:8
flashy 12:8
flat 123:14
flavors 89:20
flawed 30:19
fleet 71:5 169:7 190:7,7 209:9,12 239:12 240:4 242:5,13,17 248:8 325:12
flexibility 47:16 48:15 370:20
flexible 370:12
flight 40:8 139:18 142:6 217:12 375:3
flipped 78:1
floor 24:18,21 25:3 33:8 35:6 37:7 43:3 51:3 103:9 110:18 290:8
Florida 145:2,7 146:1
flow 36:14 38:20 39:7 105:3
flowing 38:7 44:12
flows 182:17
fly 141:9 153:5,10 158:5 158:9 217:14
flyer 172:11
flying 131:3,3 141:7 157:21,22 158:21 159:2 334:20
focus 18:8,22 24:16 39:19 63:13 75:6 109:9 169:17 217:22 218:1,2,14 255:22 293:14 296:8 322:9
focused 8:14 10:6,11 13:18 102:20 214:5 215:7 217:4 282:14 355:21 375:4 379:13
focusing 8:18 72:15
fog 158:22
folks 19:10 70:15 198:13 215:16 261:16 272:1 319:12 328:1,5 353:1 361:1,5 380:7 380:11,12,13,20 381:3 382:7
follow 54:16 61:15 62:3 64:21 235:19
follow-up 163:17 265:18
followed 15:2,7 222:13
following 38:10 235:22 354:21
foot 61:22 219:22 221:1 221:5,6
footprint 121:3 151:7,8 151:15 152:3
footprints 125:2 127:18 128:8 151:5,9
force 242:6,8
forecast 94:16
foreign 10:20,21
foremost 290:19
forensics 200:5
forever 62:2
forget 49:22
form 104:14 128:13,15 128:18 129:11,16 130:9,17,20 143:12 143:13 212:18 300:12
formally 354:16
format 68:14 99:11,18 223:7 224:7 259:21 294:10 319:22 339:20 346:22
formation 246:10 247:7
formed 12:17
forms 268:5
formula 160:17,19 161:13
forth 151:2 204:2 361:19
fortunate 19:9 176:18
forward 20:10,10 64:5 107:10 112:9 125:19 171:16 173:3 174:16 175:2 190:21 213:18 214:11 225:8 228:9 228:11 231:7 260:13 267:10,13 268:20 269:1 270:19 271:5 271:13,17 272:19 275:6 279:17 294:14 295:1 300:3 304:22 308:19 314:12 372:16
Foster 374:15
found 28:2 34:18,19 74:2 221:22 333:12 333:15,15 334:9,11
foundation 87:1,4
four 3:17 62:19,21 72:14 143:13 157:8 254:9 263:10,10 281:1 300:11 312:21 340:18 343:9 344:11 347:17 348:4 353:22
fragmented 295:5
frame 285:11 289:19 291:4
framework 205:13 336:16 338:20
Francisco 27:13
frank 211:17 251:12
frankly 380:15
fraught 265:6
freely 10:3
frequencies 118:9
frequency 91:11,12 121:20 287:1 313:4
frequent 84:12
frequently 79:15 85:16
fresh 347:15
Friday 92:5
fridges 89:10
Friedman 339:2

friend 67:4
friendly 136:22
friends 373:5
FRN 341:13,19
front 58:6 144:14 246:5 345:3
front-end 133:8
frontier 183:20,21
fronts 128:8
frozen 32:20
frustrated 43:1
frustration 376:17
fry 140:6
Ft 129:11
ftp 90:15
Fuca 62:20 142:19 150:3
Fugro 12:18 33:17 34:1 120:11 132:3 173:16 174:13,19 181:9 197:7 368:15
Fukushima 39:2
fulfill 373:13
full 39:10 43:9 48:20 49:5 50:15 52:22 125:12 145:6 151:11 186:12 222:12 241:12 246:21 275:18 290:8 309:22 331:20 357:13 372:21,22 373:6
full-day 367:2
fully 83:18 116:21 134:12,19 270:10,11
function 345:17,19
functional 134:12 258:2
fund 225:4
fundamental 18:22 283:16
funded 50:18
funding 190:7 204:8 212:8 240:19 241:21 380:10
funny 33:11 222:15
further 12:15 61:9 113:21 176:8 180:22 299:13 363:20
fuse 57:6
fused 139:21
fusion 119:21
future 9:16,19,22 18:10 18:13,17 40:13 43:18 48:4 63:19 64:11 65:4 69:4 80:10 158:19 160:4 171:10 182:12 188:20 196:13 238:2 238:14 242:13 255:22 268:20 282:17 303:3 304:21 305:13 308:13 308:19 322:15,18 325:9 334:1 337:6,14 343:1 363:21 371:10
futuristic 251:10
fuzzy 145:19

G

gains 344:22
Galveston 194:16 327:14
game 296:5 380:8,13 381:11
gap 151:9 152:12 269:18 286:5,6
gaps 152:15 172:9
Gary 1:20 13:20 160:9 163:16 191:6 373:20
Gary's 14:1 176:19
gas 27:19 28:6,16 30:4 30:5 31:9,14,22 32:20 200:8 208:10
gathering 181:13
gauge 112:3
gauges 141:18
geared 318:6
gearing 312:8 318:4
geeks 39:14
geekyland 228:2
geez 220:6
Geiger 157:2,14
general 89:7 117:21,22 121:5 136:20 137:5 158:7 176:15 324:17 348:9 369:8,11
generalization 226:18 234:3
generalize 43:12,13 237:18 317:3
generalized 227:5,22
generalizing 228:5
generally 196:22 279:14 322:14 366:2 366:20
generate 16:4 84:8,9 135:11 199:20 229:7
generated 172:8
generates 16:7 85:14
generation 22:6 26:12
generational 62:10
generic 264:10
generously 190:2
gentleman 90:7
geo 80:1
geodetic 2:3,11 333:12 334:7
geoid 142:2
geologist 43:2
geophysicist 43:2
geophysics 49:13
georeferenced 46:4,5
Geoscience 175:7
geospatial 72:19,20
Germany 146:8
getting 41:17 103:2 104:6,7 109:9,11,11 112:11 115:20 118:16 119:3 121:5,7 122:11 123:3 125:17 126:19 126:20 131:13 132:16 133:11 142:21 143:5 143:6,15 144:3,8 147:13,13 150:5 154:6 158:8,16 175:8 175:11 196:18 210:18 218:9 231:3 245:13 250:6 264:20 269:22 278:16 284:17 285:13 288:12 318:4 341:9 358:10 369:18,22 375:4 380:22
GI 162:1
giant 58:8
GIS 72:8 77:4,10,20 92:1
give 11:10 14:20 38:2 39:4 54:21 86:2 97:7 113:14,21 116:21 138:5 153:10 166:15 190:3,20 198:2 209:13 212:8 219:2 222:4,11 237:21 266:7 274:14 283:17 293:3 298:19 315:7 322:9 326:12 328:22 329:12 334:6 335:10 338:20 352:5 353:1,3 360:18 361:4 363:8 363:21 365:8 370:4 375:18 377:18 383:9
given 45:6 135:15 241:2 243:6 281:8 312:22
gives 35:4 41:22 144:16 149:15 280:1 297:16 360:16
giving 68:6 154:7 223:4 360:22 369:19
glad 34:2 36:2 157:13
Glang 219:7 356:8
glassy 123:14
Glenn 2:12 269:8 271:16 278:10 282:16 345:10 368:10
Glenn's 345:13 368:10
glider 39:9 40:3
gliders 359:7
glimpse 326:12
global 364:16
globally 174:21
GNP 105:17
GNSS 165:4 334:17
go-round 379:7
go-rounds 373:9
go/no-go 45:6
goal 6:19,20 57:16 73:20 74:3 95:2 205:16 251:1 292:19 346:22
goals 75:7 165:8 169:12 363:10
God 249:3
goggles 21:5 37:16,19 38:12 46:20
goods 87:13 95:19,21 95:22
Google 234:9 238:2 354:6
gotten 230:12 357:8
government 5:16,16 57:8 74:22 89:6 175:3 239:20 249:11 251:12 251:19 253:5,6 261:5
governmental 253:1
Governor 322:7 365:13
Governor's 340:6
GPS 334:17
grad 36:4 45:16 108:20
graduate 17:18 19:10 45:19
graduates 45:18
grammar 293:12
granted 285:6 300:16
graph 132:8
graphic 124:7
graphics 114:15,16,17 114:18 115:2,5
grassroots 68:18
gravel 191:19
gray 277:7
greatest 58:11
greatly 93:7
green 121:18 122:7 123:2,19 124:11,15 132:19 143:20 157:16 158:13
grid 108:22 109:2 172:7 224:18 229:9,11 230:17 237:16
gridded 109:2,16
ground 57:22 68:9 127:13 143:21 158:2 165:5,7 314:12
ground- 164:19
ground-truth 148:6

164:21 165:16
ground-truthing 149:6
grounding 296:2
group 3:3,4,10,15,17 12:16 13:13,17,22 15:9 16:14 17:6 18:18 30:14 69:17,17 71:4 71:17 79:22 110:15 113:3,11 114:3 131:1 166:16 167:19 168:14 172:21 173:2 183:16 183:19,22 185:20 186:5,7 187:12 188:2 189:15 193:2,15,20 193:21 195:22 196:11 196:21 197:10 201:18 210:10 215:12 264:17 295:7 296:22 305:22 307:19 309:1 311:11 311:15,21 312:1,16 318:1,13 328:22 331:12 337:18 344:16 350:1,2,4,17 355:21 356:1,4,13 360:4 364:17 378:2
groups 188:6 195:21 244:15 295:5 296:21 312:5 318:3 321:12 338:1 355:17
grow 18:3 68:9 73:19 74:7
growing 147:5 149:19
guarantee 31:8
guaranteed 84:14,20
Guard 5:21 7:4 8:14 10:10 249:3 257:22 263:9
Guard's 271:1
guess 9:7 16:16 27:1,3 32:5 40:12 42:8 43:12 56:11 63:7 103:22 108:16 166:19 167:2 174:20 176:7 180:14 181:5 196:10,12 197:13 202:2 205:21 206:3 208:3 226:12 230:9 252:2 256:15 275:9 299:1 301:21 313:13 320:5 341:9 354:13 370:1,3 371:16 373:12,13
guidance 54:16
guidelines 67:21 250:21
guilt 204:17
guilty 204:17,17
Gulf 42:2 200:6
guys' 206:21
gyrostabilizer 135:2

H

habitat 49:13 169:14 261:15
half 128:11 130:5 137:5 187:10 207:15 228:12 232:10,10,11 241:3 299:9 357:12 359:16 360:14 362:13 381:2
HALL 1:16 7:17 53:3 56:11,18 57:7 185:16 186:14 188:3 194:4,7 194:22 195:2 206:4 206:14,17 264:19 269:20 288:10 289:7 290:14 293:5,16 305:19 307:11,16 313:8,22 314:4 325:18 327:6,9 329:20 331:14 333:4 335:1 341:11,18 342:2 345:9,16,20 346:2 350:19 351:17 359:3,13 367:19 368:14 377:11
Hamburg 76:4
Hamilton 221:20
hammering 284:22
Hampshire 2:2,6 150:20 177:2 184:13 200:19 203:18 205:19 357:10,18 359:5 364:3,21 371:4 372:16 373:1 374:13
hand 88:19 91:16 198:1 198:2 241:21 257:11 355:13 376:8
hand-in-hand 371:21
handheld 46:2
handle 89:9 91:10 93:4 106:17 192:2 379:20
handles 77:3 235:14
handling 74:13
hands 74:11 342:1
hands-on 362:1
hanging 137:11
Hanson 1:12,14 4:8 213:5 215:4 239:7,10 243:4 258:11,19,22 259:5,13 260:5,9,14 266:15 269:8 286:1 286:21 287:3,8 293:15 296:17 298:21 299:6 314:7 329:15 335:12,16 337:15 338:9,11,15,17 339:8 339:11 342:12 343:4 343:8,11,16,22 344:4 355:7,11 356:6,15,17 364:2,5,8 373:8,18 374:1,3,7,9,11,17,19 375:1 376:16 377:10 378:15,18 379:4 381:15 383:5,14
happen 36:16 37:3 39:2 76:20 88:18 89:18 102:17 175:13 217:8 304:5
happened 28:17,19 37:3 101:16 157:12 203:5 253:20 280:13 284:20
happening 15:11,12 31:5 52:12 76:9 78:20 87:19 88:9 92:18 97:8 111:2 167:4 173:17 174:4 212:19 266:3,5 276:3,4
happens 30:21 93:1,5 95:11 126:15 201:3 259:2
happy 60:10 150:11 223:10 312:19 325:4 361:22
harbor 45:5 46:14 48:11,12 49:3 74:13 79:21 105:3 244:10
harbors 245:10 246:2 246:15,17,20 255:6 288:3 289:4 290:8 297:9 299:19
hard 14:6,15 59:1 97:3 117:10 128:19,21 153:7 154:19 155:1 180:8 186:1 194:8 195:5 208:10 303:11 331:18 377:13
harder 130:9
hardware 163:4
harmony 227:18 230:19
harness 184:2 251:14
harnessing 184:15
hash 285:19
hat 164:9
hatch 118:5
hate 207:11 273:12
Hawaii 280:12 281:3
HawkEye 120:15 132:13 134:15
hazardous 87:13
he'll 209:16
head 20:2 133:18 135:2 174:9,11 359:17
head-on 66:5
heads 60:13 347:16
health 149:15
healthy 19:14
hear 15:6 22:16,16 36:2 51:19 52:6 60:10 150:18 176:14 287:21 303:12 319:11,13 320:6 321:10 324:15 328:10,13,14 330:6 332:9 347:19 361:3 364:10,17 369:11,14 371:8 379:1,8,16
heard 7:11 11:7,13,15 11:15,21,22 19:15 43:21 51:7 52:21 72:3 79:12 173:14 244:7 267:11 271:21 301:22 302:10,13 306:3 318:17 319:16 320:9 323:9 327:10 344:21 345:10 367:1
hearing 224:21 295:13 363:2
heartburn 142:14
Heather 5:18
heave 25:13
heavy 140:2
height 44:17,21 133:19
held 88:7
hell 366:1
Hells 191:19
help 8:5 29:9 48:19 73:1,1 80:17 84:9 85:7 86:11 180:13 188:13 270:19 285:14 293:6 310:14 319:20 325:10 328:7 331:2,9 332:8 346:16 360:17
helped 310:8 321:16 351:3 361:14,17
helpful 44:8 355:20 359:19 364:14 377:20 378:1,9 382:17
helping 86:1
helpless 314:21
helps 20:9 46:19 83:1 165:16 175:3
Hempstead 65:17
herding 352:20
herring 159:9
hey 174:16 206:9 257:11,16 361:2,5
Hi 4:19 64:20 153:16
high 17:2 27:19 43:13 48:9 50:11,20 54:1 67:13 98:3 118:8 138:19 140:14 148:22 158:5,21 223:5 251:2 251:3 282:17 283:1

283:21 285:18 308:8 327:13 337:1 348:13 348:15 380:12,20 381:3
high-power 120:4 136:20
higher 111:21 129:19 158:9 232:6 236:8 284:10
highest 221:3 242:18 261:8
highlights 340:3
highly 76:2 88:15 89:21 200:7 226:5,5 306:12 306:14 307:19
highwater 308:2,20
highway 215:21
highways 216:2
hillside 144:6
hinterland 95:17
hired 242:7
hiring 241:16
historic 54:3,4,7 63:4
historical 138:1 191:5
historically 128:5
history 174:15 318:5,5
hit 121:4 140:3,4 155:22 192:7 288:14 304:15
hits 122:9 123:20 124:6 270:2
hitting 114:14 285:3
Hmm 338:16
Hogeweg 2:21 3:7 72:10 98:8,12 99:15 106:11
hold 85:4 89:15 243:22 353:11 354:16 357:6 370:16
holder 81:10
holding 46:4 166:11
holds 235:17,17
holistic 102:21 287:15 350:7
holistically 101:22
Holland 5:22 323:21 325:19
home 295:16 370:3 375:3 380:6 383:17
homework 351:21
honest 163:15 332:2 367:7 376:5
honestly 75:14 89:4 204:13 274:8 354:6
honesty 50:22 154:4
honor 228:8 382:4
hood 237:10
hooked 356:10
hope 5:3 16:3
hoped 168:14
hopeful 241:7
hopefully 11:11 17:21 71:19 73:2 197:11 205:20 239:13 258:16 299:10 301:11 338:3
hoping 20:6 230:2 334:6
Horizon 28:18,19 38:4
host 271:3
Hotel 1:11
hour 30:16 94:17 110:15 299:9 360:14
hours 30:14 31:6 94:17 215:11 231:2 244:22 294:20 370:6
house 28:20 29:1 177:1 184:16 185:9,13 381:5
housekeeping 335:18 355:8
housing 75:2
HSIA 203:16
HSR 188:14
HSRP 1:14,15 2:7,16 3:4,16,18 12:16 168:12 195:6 201:5 213:6 308:14 312:15 313:10 318:5 323:16 328:22 329:22 340:14 340:15 341:13,20 353:9,10,17 354:9 355:12 368:4,22 381:18
hue 146:16
huge 28:11 29:1,2 105:17 133:19 135:6 156:8 162:18 228:9 351:3 352:5,5
hugely 155:6,10 373:3
Hughes 169:5 239:16
huh 373:12
hull 48:21
human 60:11 137:13 227:10
human-computer 18:22 21:9
human/computer 63:9 66:20 181:19
humps 128:15
hundreds 156:11 200:13
Hungary 95:22
hurricane 36:22 37:4 94:17
hurricanes 7:10
hurt 266:13
hydrate 32:20
hydro 86:20 108:21 228:18
hydroacoustic 55:18
hydrodynamics 58:5
hydrographer 2:15 11:2 222:6 280:13 285:22 371:18
hydrographic 1:4,11 2:2,6,12,15 3:5 4:4 5:1 8:1 10:18 17:1 27:6 29:16 35:1,2,13 36:10 40:10 54:2 99:22 111:8,10 117:20 191:7 198:11 203:7 204:1 208:4 244:16 262:7 328:8 343:22 345:21 371:12
hydrography 114:3 202:1 262:11 363:9
hydrophone 25:15
hyperspectral 118:15 137:14

I

ice 59:11 155:5
Idaho 191:18
idea 44:1 119:20 178:5 187:20 211:18 248:4 255:3 282:11 302:1 326:17 331:5 355:18 371:5,7 377:18 382:16,16
ideas 41:22 42:13 184:12 213:9 214:18 248:2 266:22 273:21 274:3
identical 246:6 247:7 247:11 255:17
identification 122:15
identified 286:4 287:19
identify 31:20 46:6 148:7 211:20 242:10 242:10 267:9,20 268:4,17 380:3
identifying 380:4
ignore 20:3
IGWG 69:16
IHO 10:16 67:21 68:13 69:11 99:13,17 108:3 131:17 132:10,10 133:9 151:2 160:17 192:3,4 258:9 274:16 278:6 286:8,19 287:1 287:16,22 297:11 299:20 317:8 336:5 342:19
II 121:11
III 120:15 132:13 134:15
illicit 53:9
image 41:1,2 133:17 146:18 148:12,17 149:14 150:2
imager 119:12
imagery 47:2,19 70:9 119:19 137:22 138:1 148:4,9 149:13 154:13 155:10
images 40:21 145:13 149:17
imagine 91:20
imbedded 59:16
immediate 76:16 108:5 108:7
immediately 177:10 220:8
IMO 258:8
impact 76:19 157:5
impediments 379:17 380:2
impel 270:19
imperative 304:17
implement 85:1 106:13 289:3,21 315:18
implementation 72:7 246:16 322:5 337:12
implemented 50:18
import 104:20
importance 10:16 11:8 183:10 302:11 333:14 333:19 335:6 336:8 342:20,20 344:20 358:1
important 5:12 6:4 7:12 7:13 10:12 14:8,15 22:17 55:6,10 59:9,15 101:1 138:12 140:11 145:18 155:6,10 157:20 272:6 318:7 318:10,22 319:4,8 320:11 322:22 323:6 326:12 339:10 351:18 367:4 382:9
importantly 41:4 45:9 274:2
imposed 54:17
impressed 11:18 22:9 304:14 323:20 324:14
impression 309:8
impressive 52:13 217:10 324:1
improve 76:8 86:2 94:19 101:8 105:8 106:14 192:10 266:5 315:14,19 375:7
improvement 193:12

327:13
improving 95:3 245:14 255:12 307:4
IMU 165:4
in-depth 205:5 309:22
inaccuracy 123:11
include 56:13 184:4 237:22 250:12 257:17 281:19 301:19 339:5 356:4
included 14:9 57:18 246:9 282:3 289:2 300:10
includes 200:11
including 42:1 107:13 185:11 259:15 297:11 299:20 316:3 364:11 368:7 373:7
incoming 306:15 344:15
incorporate 209:22 244:2 305:12 307:8 343:6
incorporated 12:3
incorporating 44:20 52:19 244:7,12
increase 60:15 75:8 126:5,16 127:1,2 357:22
increased 12:5 56:4 118:7 119:1,4 135:7,8 157:9 212:8
increasing 111:16 220:19
incredible 133:6
incremental 40:13 220:20
independent 121:22 163:19 164:3 169:7 239:15 246:10 247:8 247:19,22 248:3,7,14 249:12 255:4,9 256:21 260:11 262:14 264:9,21 266:1,21 267:3 269:12,14 279:22 281:18 282:8 283:7 290:12 293:1
indicate 88:8 123:7 241:8
indication 138:5
indigenous 59:10 185:11
individual 19:21 77:16 84:12 86:15 88:14 91:22 186:3 349:3 351:18
individually 104:21 354:5
individuals 19:4 354:11 365:13
industrial 271:8
industries 380:7
industry 7:21 10:15 28:13 30:7 67:14 68:21 70:15 101:12 113:13 162:20 167:6 175:3 196:22 197:5,7 197:14 198:13 199:8 199:11 200:8 239:15 239:18 253:3 254:12 261:4 288:13 329:1 330:10 340:6 362:20 380:7
inertia 318:3
inexpensive 46:10 47:15
influence 373:10
influential 251:21
inform 80:17
informal 195:22
information 7:2,20,22 19:7 21:13,15 22:21 53:7,8 55:5,7 57:10 59:6,13,16 64:16 70:9 77:2,7,18 78:18 86:3 86:7 87:20 89:1 92:2 92:3,22 106:8 107:13 107:19 115:6,20,22 122:11 137:20 138:3 149:15 182:21 188:10 208:21 319:18 321:20 362:22 363:17 365:17 367:21,22
informational 360:2 365:21
informed 94:13
infrared 121:17 122:14 123:14 149:14
infrastructure 14:3,5,8 14:10,14,16 73:14 93:12 97:1,2 102:16 184:21 196:15 208:15 333:20 335:8 336:13 336:14,18 344:20 345:8 346:17
initial 168:19 351:11
initiated 264:2
initiative 364:16
initiatives 89:6,22
inland 250:12
innovate 217:20 218:9
innovation 198:10 216:6 217:19 218:2 243:11 379:11,18,20 379:21 381:7
innovations 217:5
innovative 358:14,15 359:2
input 19:12 167:6 193:9 257:19 258:2 319:1 349:11 350:13 364:19
inputs 351:19
inputted 364:20
inserted 299:17
inside 15:11 266:6 294:12
insist 266:21
insistence 261:6
inspect 82:10
inspections 78:16 82:19 208:16
installment 241:1
instance 57:13 58:2 236:11 312:18
instances 123:17
institutes 29:9
integrate 151:1 185:8 267:15
integrated 59:3 98:18 98:19 185:10
integrating 185:12 325:1
integration 105:11
integrator 171:14
integrity 30:19
intend 340:20
intensity 146:20 147:9 147:15,15 148:10
intent 198:22 200:21 224:13 225:11 227:12 253:12 354:3
intentionally 156:9
inter-Panel 295:4
interaction 19:1 21:9 22:14 42:11 63:9 181:19 198:13 279:4
interactions 41:13 123:21 124:1,8
interactive 41:19 330:17
interacts 201:12
interagency 248:20 249:9,12 263:5 279:8 283:1 288:12 291:3
Intercoastal 50:10
interest 16:4 214:13 345:5
interested 9:15 147:2 194:1 234:6 237:14 282:22 322:4 332:6 346:15 361:6 362:14 363:2
interesting 7:19 8:13 8:20 9:3,9 26:13 39:12,21 70:19 86:9 93:22 97:12 99:20 101:10 149:9 170:18 170:21 171:22 172:16 173:8 174:19 175:15 176:7,13 177:5,14 188:14 196:9 237:7 304:3 333:16 361:10 368:5,17,20
interestingly 224:3
interests 58:2 253:8 279:6
interface 66:20 99:4
Interior 72:18
intermodal 106:2,4
internal 77:11 98:7 196:5,5 294:18 362:18
internally 75:17 80:19 172:18 197:8 246:13
international 10:18,21 11:4 68:16 246:18 277:13,20,21 289:5 290:3 305:1
internationally 101:21 238:7
internet 12:6
interrelation 357:20
interrogate 22:21
interrupt 169:22 357:5
interval 91:19 231:14 232:7 236:6 246:22 290:10
intervene 274:4
intervening 272:11
intervention 227:10
intimated 270:18
intrigued 228:14
intriguing 25:19
introduce 4:16 5:5 13:1 16:11
introduction 3:8 15:17 194:12
intuitive 230:14
intuitively 230:15
intuitiveness 63:10
invaluable 203:19,20
invention 198:10
inventory 12:3,13
investment 216:5,7 243:9,12
invite 193:22 273:12
invited 113:13 331:6
inviting 273:2
involved 4:22 15:6 45:15 70:13 89:21 102:20 177:9,12 180:7 182:2 185:20

215:16 250:2,4,17 271:1 295:8 304:8 340:16 377:17
involvement 310:1
involves 311:12
IOCM 203:15
IOOS 220:15
Island 304:2
isolated 226:12,14
issue 3:11,17 6:7,15 8:15 18:9 40:14 43:4 54:13 55:11 66:20 97:16 98:1 103:16 110:1 141:5 154:9 180:22 193:3,6,8,13 196:20 206:1 207:7 207:12 211:18,19,20 212:4,5,6,11,11,12,17 212:18 214:2,9,11 225:22 243:16 244:17 267:4,13 272:7,15 274:9 275:10 278:18 278:19 279:2,9 280:11 287:11,14,18 291:10,22 292:7 297:20 298:6 299:11 300:15 301:11 304:11 309:9 310:4,5,9 311:15 312:4,8 317:10 318:16,16 319:6 333:22 334:2 337:17 338:5,7 350:4 360:1,8,10,11 363:16 363:17 365:16,22 376:2,12 377:3 379:1 379:2,8
issues 11:4 13:21 29:22 57:3 62:10 104:1 122:22 165:9 167:10 173:9 190:4 209:9,12 214:13 215:20 218:16 225:19 244:7,12 250:3,4,19,19 276:21 278:14 282:20 283:12 283:20 285:7 291:18 301:8 308:9,12 311:11 317:22 337:17 347:15 349:20 350:6 351:3 357:14 360:7 363:15,22 367:13 369:22
item 12:15
items 308:10 335:18 365:11
iterations 223:3
IV 121:20

J

J 1:17,19
Jacobson 220:10
JALBTCX 114:19 118:19 126:2 128:9 160:16
January 365:1
Jeff 15:21 247:15
Jersey 52:17
JHC 14:21 197:17 203:17 210:8
JHC/CCOM 15:2
JHC/Center 168:20
JIM 2:13,19
job 39:19 55:4,8 128:4 139:3 162:10 233:3 294:1 330:15
jobs 155:3 187:17
John 169:5 172:1 177:2 179:18 239:16
joint 2:2,6 3:5 16:22 114:20 198:12 200:19 203:7 220:13
jointly 88:10
Jon 110:19,20,21 131:17 291:6
Joshua 340:5
journals 21:19
Joyce 1:15 4:6 6:18 11:17 61:20 192:20 193:4,16 203:12 213:11 243:15,17 267:7 276:6 277:16 280:3,19 294:7 300:7 301:12 309:7,16 327:6 342:4 344:12 351:2 353:5 354:2 376:12
Joyce's 51:17 309:3
Juan 62:20 142:19 150:3 304:2
Juliana 2:3 9:22 145:14 201:8 306:21 321:10 328:5 362:4 369:6,10 372:11
Juliana's 201:16
July 309:20 362:16
jump 57:12
jumped 172:2
June 309:20 341:5,7,14
jurisdiction 263:15 273:4
jurisdictional 276:21

K

Katrina 228:18
Kearns 4:19,20
keel 74:8 84:18 220:12 233:17
keep 13:7 20:3 24:10 60:21 66:21 79:15 101:16 141:18 175:18 194:8 201:1 210:20 227:11 239:12 284:9 284:10,21 297:4 299:1 338:7
keeping 60:20 206:22 219:7
Kelly 1:17 11:17 50:7 103:11 105:5,13 177:2 267:7 269:16 270:17 271:17 294:7 295:1,11,18 304:13 305:16 358:11,22
kept 32:11 38:17 254:13
key 48:15 81:22 83:4,11 191:20 285:2 294:16 305:3 323:4,15 345:1 345:17,18 361:16
keyed 194:13
keynote 367:20 368:20
keys 97:3 146:1
kicked 170:16 296:7
kidding 243:6
killed 226:12
kilohertz 131:11
kilometers 73:13 79:4
Kim 1:16 6:9 7:16 53:2 185:15 192:22 211:16 297:14 307:3 363:14 377:3,6
Kimpton 1:11
kinds 21:10 33:3 47:9 112:10 248:5
kit 20:12
knew 187:9 230:21 275:7 280:17 310:14 330:15,19 335:4
knitting 207:4
knocking 62:21
knots 67:1
knowing 101:16 331:17 377:14
knowledge 318:11
known 187:15 230:15 310:8
knows 41:11 70:19 229:4 344:16 350:15 366:1
Kudrna 211:17
Kurt 175:21

L

L.A 373:3
LA 87:15 105:21 219:12 224:3
lab 16:21 18:19 21:8 24:17 28:12 31:12 36:8 39:13 44:18 50:17 65:6 173:21 210:8 325:10
laboratories 68:4
Laboratory 2:20
labs 28:12 71:2 197:3
LADS 120:11
Lafayette 174:12
lance 25:22
land 11:14 119:10 126:16 143:22 146:15 146:15 164:21,22 165:3,6 183:6 237:3 249:17 251:7 254:2 358:3
LandSat 90:19
language 241:8 299:16
languages 300:8
laptop 21:4 46:18,19 108:1
large 17:19 20:14 50:14 90:5 91:10,21 93:10 116:6 121:3 133:16 133:17 159:11 178:18 193:7 219:16 238:20 239:4 256:12 314:16 362:10
largely 165:12
larger 127:8,15 128:7 146:12 151:5,15 188:11 227:10 316:18
largest 73:6,8 84:1 174:20 231:8
Larry 2:5 3:6 14:20 16:9 50:3,7 63:10,19 66:10 71:12 98:2 108:22 177:6 181:20 199:15 204:14 254:21 279:16 297:3 299:16 324:4 330:14 365:7 369:6 372:18
Larry's 15:1 58:22 336:4 342:18 367:10
laser 24:10 46:22 118:8 118:22 119:2 121:17 121:18,18,20 122:3,7 126:4 127:6,11 131:9 134:13,13,18 157:10 157:16 158:13
lasers 121:22
lastly 146:4
latest 16:7 44:4 159:14 369:12
Lauderdale 129:11
Laughter 23:19 27:2 150:14 159:6 204:16

308:4 334:16 335:3 344:6
launch 58:7 61:22
launched 90:20
laureate 33:13
law 75:2 87:9
Lawson 1:15 10:4 11:5 58:21 59:22 263:6 282:10 296:17 314:1 314:4 350:22 351:13
lay 138:16
layers 38:2,3 42:1
lead 13:4 55:1 173:20 174:7 217:13 268:9 312:20 340:6 343:13 343:15
leaders 271:9
leadership 306:16 382:8
leading 304:19,20
leads 200:15 324:20
leak 29:4 32:1,4
learn 188:16 303:14 307:22 313:15 315:16 375:6
learned 5:13 187:14 216:15 282:21 308:18
learning 188:7 362:15
lease 35:11,17 81:10
leased 83:21
leases 81:9
leave 49:22 51:3 74:5 90:11 150:1,8 177:15 305:21 381:12
led 12:18 18:16 28:11 41:14 76:21 322:13
left 80:5 83:13 88:19 128:16 134:21 166:2 179:8 195:14 247:21 274:22 335:21
legalized 108:11
legislation 203:15,16
legs 156:13
Leica 120:15 134:9
leisure 108:14
length 165:12 206:11
lessons 308:17
let's 5:6 20:5 69:12 70:2 112:16 114:9 115:15 171:10 189:4 195:10 195:14 214:6 262:1 271:11,11 294:3 314:7 339:3 346:4
letter 190:13 214:18 271:5 275:15 279:5 288:21 294:15 298:13 300:7,10,21 301:4,6 301:19 302:5,12 304:18 307:13 313:12 317:11 332:14 333:2 335:13 336:3 339:18 340:1,3 344:13 347:13 348:15 365:12
letters 284:19 376:3 377:5
letting 25:4
level 17:2,17 38:19,20 65:14 67:13 158:2 161:6,8 163:4,13 197:11 231:8 236:18 267:17 278:15 282:17 283:1,9,10,21 284:9 284:10 285:18 289:13 323:2 330:21 337:1 343:1 348:14,15 359:11 369:11 380:12 381:3
levels 40:1 71:9 72:5 160:11 162:7 163:8 380:20
lever 219:22
leverage 375:19
liability 296:1,15
Lidar 3:8 15:17 51:19 51:20 52:3,5,8 113:10 113:11,17,18 114:20 114:21 115:17 116:3 116:14,19,20 117:2,6 117:13 118:16,16,19 119:17 128:7 132:5 132:18,21 133:18 135:14 136:3 138:4 142:10 146:6,11 148:14 150:4 152:1 155:18 157:2,6,12 158:1 160:11,13,13 179:3,3 254:2,4,15 305:7 359:14,18
life 30:11 40:5 94:18
light 124:1,3 126:8,12 136:16,16,18 140:12 267:5 296:11
lighter 118:7 131:9
lights 63:20
liked 97:13 223:8
likes 376:9,10
Likewise 139:4
Limitations 3:9
limited 75:19 89:4 95:7 117:12 322:19
limits 103:6 112:5 117:3
Lindsay 1:16 3:3 8:11 12:18 13:1 72:10 113:3 154:18 177:17 196:9 218:19 246:3 351:14 375:7
Lindsay's 13:3 258:12
line 28:3 57:1 70:18 92:9 130:5 132:9,10 132:11,19 139:15 141:7 153:12 223:15 233:9 275:11 286:12 300:14 334:1
lines 6:1 57:13 70:11 107:3 139:19,21 146:11
linked 48:16
liquid 80:15
list 121:9 186:3 242:16
listed 361:19
listen 213:8 284:3
listening 284:3
literally 85:9 200:11 222:21 326:22
little 5:9 9:6 18:8 20:15 23:7,12 25:18 26:12 32:1,16 34:14,18 35:9 58:7 62:17 63:4 68:3 72:12 88:7 95:6 104:5 106:5 107:1,22 109:19 114:2 126:2 128:18 130:2 131:15 134:1,9 136:5 137:7 142:13 147:8 150:18 151:16 154:8 159:9 159:12 162:2 163:22 164:15 183:4 186:9 186:18 187:3 188:21 199:2 204:2 207:6 211:8 213:13 225:16 244:4 257:15 262:6 265:8,14 273:1,11,18 273:22 279:9,11,13 300:19 306:13 329:10 330:2 331:2 333:7,8 335:17 338:5 344:18 347:19 353:5 358:9 359:1,17 361:22 362:15 365:4 370:8
live 5:2 71:6 89:9 100:21 376:9
lived 254:7
Lizzie 243:5
load 179:22 351:3
loading 219:13
local 9:6 52:14 74:22 87:9 308:11
locate 33:15 34:9
located 34:20
location 77:14,15 84:5 86:15 93:22 94:7 144:15,16
locations 82:4 88:19 141:2 156:10
lock 311:8
Lockhart 1:17 3:9,11 52:7 113:15 114:13 115:13 151:3 154:1 155:12 157:7 159:5,7 160:20 161:3,7,12,15 161:21 163:14,20 164:2 165:6 265:17 266:10,19 275:9 277:6 286:3,17 287:7 287:10 288:17 317:7 364:9
log 98:20
logic 261:20
logical 229:6
logistics 96:7
logs 144:7,9
long 28:3 45:21 67:18 70:17 87:7,15,18 88:4 91:8 95:7 108:2,2 109:4,5 117:14 163:6 177:13 190:17 204:22 207:7 219:12,17 220:11 224:1 225:12 225:15 230:9 232:4,8 237:10 244:21 251:9 256:12 324:8 367:5 375:3
long-winded 202:9
longer 67:10 118:3 130:10 205:6 206:2 360:4
longest 73:7 284:6
look 8:2 17:16 18:12,17 20:5 25:4 35:3,8 36:16 38:22 39:10 42:6 43:10 46:4 48:4 61:13 66:16 67:5 68:7 68:8 70:8 78:4 81:22 94:3 95:9,16 109:1 111:17 118:19 124:9 125:17 129:9 130:3 134:20 137:22 138:7 139:1,4,13 144:10 146:20 148:15 159:11 162:16 184:1,14 191:12,21 205:14 216:8 220:1 224:15 224:16 225:17,21 233:19 242:13 256:1 263:20 271:7 284:19 286:18,19 307:4 308:17 351:6 371:12 372:15 375:21,22 376:18 377:14 381:1
looked 36:7 149:20 179:20 201:9 223:6

looking 20:10 21:20 22:6 25:2,9 26:1 27:9 35:10 36:13 37:21,21 37:22 39:2 42:12 50:9 50:11 59:4 60:12 61:4 61:6,6 66:21 80:1 96:3 102:22 104:1 106:13 115:15 125:19 125:20 133:14 139:20 144:18 155:4,8,9 186:2,8 189:5 203:9 226:8,17 228:19 253:15 255:1 261:10 264:12 295:1 303:18 303:21 304:4 329:1 341:22 382:13
lookout 60:21
looks 19:4 20:18 44:6 269:10 379:14
loop 229:18
loops 25:19
looting 54:5
Lord 333:17
Los 95:19 217:14
lose 207:2 347:18
loses 330:7
loss 76:17
losses 147:11
lost 216:21 285:22
lots 14:4 29:22 47:16 181:9 184:5 226:13 253:6 318:13 320:9 324:13
louder 328:15
love 61:1,14 180:10 287:21 329:4 354:6 359:7 360:21 381:6
loves 39:15,18
low 50:22 55:21 56:3 115:12
low-power 120:19 121:6 127:17 131:8 137:3,4
Lowe's 215:18
lower 91:16 137:8 159:2
lower- 120:7
lower-power 125:1
luckily 224:6
lucky 156:3
lunch 5:15,19 71:19 189:16,20 195:15,17 213:1 248:1 345:14
lunchtime 367:14 368:7 368:19
Lynn 110:17 177:20 178:6,14
Lynne 2:16 193:17
195:4 331:11 339:21 376:21 377:3 382:18

M

MacCready 9:12
machine 36:22 89:14
machines 89:11
Macondo 30:9 200:5
magnetic 38:17
magnitude 296:14
main 104:22 125:16 131:7 199:13
Maine 178:20 373:1
maintain 75:21 84:16 267:3
maintained 246:15,20 276:8
maintaining 276:10
maintenance 76:18 83:2 84:15 259:7 362:12
major 6:9 228:10 252:19 316:7 324:21
making 4:21 66:9,9 67:2 76:14 77:21 165:16 197:19 243:9 246:12 247:8,12 261:20 352:17
Malaysian 368:16
male 26:16 308:5 334:19 335:15 353:18 359:12
mammals 25:10,10
Man 115:9
man's 222:19
manage 77:6 79:11 83:8 103:21 231:8
managed 236:22 237:1
management 59:3 76:11 77:7 79:18,21 87:12 105:6,15 185:10
manager 2:21 72:7 82:7
manager's 56:8
managers 54:9 55:6,8 74:20 81:22 83:1 208:14
manages 362:9
managing 76:10 87:20 219:6
mandate 292:1
mandated 291:12
manner 11:12 163:9 229:7
manual 227:19
manufacturer 89:17 99:5,10
manufacturers 197:2
380:18,19
map 29:20 62:4 77:20 81:8 82:2 108:22 109:2 147:3 249:17
mapped 58:7 286:12,19
mapper 173:20
mapping 3:5 16:22 35:6 49:13 52:18 54:20 55:12 62:17 78:7 80:22 100:19 117:19 117:20 168:20 169:15 169:15 173:10 203:8 230:4 242:15,22 326:5 364:16
maps 10:20 77:21 78:2 78:4,4 80:20 81:1 234:9
marathon 87:16
Marcus 175:21
marine 2:17 10:12 25:9 25:10 27:8 42:15 59:3 59:20 263:14 282:17 283:16 291:14 365:20
mariner 58:12 68:6 100:11 109:16 171:8
mariners 19:12 41:17
maritime 23:3 65:10 86:16 184:9 340:6 361:8 366:4
mark 2:11 96:21 284:7 308:2
marks 191:9,21 192:9 308:20
Marten 2:21 3:7 72:1,9 330:15
Martin 15:3 24:9 174:7 174:22
mashed 207:11
Mashup 41:15
mass 39:5
massage 370:8
massive 185:7
mast 35:14
master 59:12 74:13 79:22 80:4
master's 17:17 36:7 65:1
match 111:11
materials 74:9
math 361:20
mathematical 137:1
matter 104:12 112:20 156:19 213:2 291:16 293:18 299:3 311:2 383:21
matters 188:10 293:17
Maune 1:18 6:6 160:10 160:21 161:4,11,14
161:20 192:19,22 194:6 211:11,15 212:21 231:11,13 243:17 245:14,19 248:2 249:16 252:22 253:3,18 269:10,19 308:21 311:1 312:12 352:8,12,16 363:5 374:2 376:20 382:18 383:4,7
Mavericks 58:4
maximize 40:7
maximum 220:8
Mayer 2:5 3:6 16:13 21:3 23:17,20 24:5 26:9,22 27:3 32:18 34:6 35:22 36:5,12 37:11 42:20 44:16 45:17,22 48:2 50:4,19 51:9 52:10 53:2,18 54:14 56:17,21 58:18 61:2,18 62:9 69:2 71:4 98:3,10 99:1 204:15 255:1,8,15,18 262:19 264:11,14 297:4,21 298:3,9,14 298:20 324:5 331:4 371:2 372:2
MBARI 261:9
ME70 26:8
meaning 306:19
meaningful 163:9
means 73:22 118:3,10 127:20 128:21 249:12 306:20 328:17
meant 38:18 58:1 375:19
measure 122:8,18 129:3 132:5,7 137:10
measured 123:6
measurements 29:4 86:21 112:3
measures 348:7
measuring 122:20 129:1 162:10
meat 337:10
mechanism 84:21 85:2 197:17 356:1
Medley 2:15 153:16,16
meet 22:22 131:17 158:10 172:9 237:10 274:12 275:12 277:20 280:16 281:19,22 282:5 310:18 320:8 367:11
meeting 1:6 3:19 4:5,12 5:7 6:22 9:22 11:3,8 11:19 28:22 113:5,8

168:5,19,22 169:3 173:5 188:15 193:2 209:21 210:4 213:6 217:9 262:20 275:8 277:22 278:8 295:2 300:15 301:6 304:14 307:12 308:1,17 309:1,19,19,20,20 311:6,17 312:15 313:5,15,16 315:16 319:14 323:1,10 324:22 332:1 339:15 339:22 349:9 350:13 353:11 358:10 360:20 361:9,15 363:3,7 366:12,14,18,19,21 367:2,6 368:8 370:5,8 370:9,16 375:6,6 376:22 377:20 381:17 383:10,15,19,20
meetings 12:17 69:16 113:7 168:3,6,9 183:16 186:11 188:8 196:11 210:16 211:5 211:6,12 245:9 258:5 282:21 294:11 298:5 300:8 307:22 308:1 308:19 309:15,17 312:14,16 313:4 321:1,14 322:15 328:18 356:8 363:4 367:22 375:11 377:5 378:20
meets 111:19 297:7
melt 155:19
members 1:13 2:1 5:11 6:3 10:1,3 13:1 302:3 319:2 323:13 328:6 333:9 377:19
memory 49:21
Mendocino 27:14
mention 149:10,22 216:14 286:10,11 289:8 300:21 325:5 339:12 340:5,7 359:5
mentioned 54:18 78:12 80:20 85:14 107:14 131:18 144:11 151:21 153:17 157:21 161:1 173:16 181:12,15 192:22 212:14 254:10 256:19 257:3 309:14 318:22 333:5,11 342:15 359:10 383:8
merge 128:18
merit 324:18
MERSFELDER-LEWIS 2:16 5:4 193:19 341:2 341:5,15 354:22 355:10
message 14:11,13 217:21 257:5
met 1:11 187:19 339:4 356:9
metal 32:14,14
meteorological 86:20
meter 27:19 128:11 130:5 133:19 192:5 222:11 231:13,20 232:6,6,9
meters 33:7,15,18,19 34:10,21 37:11 52:4,6 79:4 107:12 116:9,13 116:15 129:12 130:18 133:5 146:17 151:22 158:2,5 231:20 234:19,20
meters' 116:8
methane 32:3
method 65:12 100:14 109:14 192:17 200:7 292:9
methodology 132:7
methods 120:16 164:10 217:5
metric 246:19 290:5 348:12
Mexico 200:6
MEYER 2:16
MH 368:16
MH370 175:5
microphone 65:19 98:15 102:2 114:12 166:11 178:7 209:11 215:3 313:21 314:3 335:14 342:10 344:7 345:15 346:12 347:9 348:22 352:21 353:13 356:16 358:21 367:16 371:15 374:16,18,22 379:3 381:14
mid 254:8
middle 55:14,15 80:3 114:11 236:10
Mike 2:10 113:10 115:4 121:12 145:12
mile 27:19
miles 156:11
military 117:15 239:20
milk 89:11
Millar 178:20
million 20:21 34:7 46:16 221:5,8,9 240:9 241:4 296:15
millions 200:11,14
mind 201:1 301:5 306:2 307:4 315:17 335:21 355:11 378:10 383:5
minds 20:13 194:17
mine 117:16
mingled 187:1
minimal 76:19
minimum 227:11
minor 6:13 246:3
minute 91:18 195:22
minutes 20:22 110:16 166:2 173:6 195:13 295:15 299:1 375:17 383:11
mirror 122:4
missed 185:17 207:19 243:3 327:5
missing 29:5 43:8 110:3 153:13 284:7 327:21
mission 273:7 368:16
misuse 53:9
mitigate 92:7 106:20
mix 180:6 242:12
mobile 88:14
mobilization 29:15
modalities 73:5
modality 3:7 72:16 89:2 96:10
mode 49:14 157:2,14 216:5
model 36:18 38:10,15 39:1 45:5 101:21 102:5 142:2 143:4 160:3 162:1 229:13 229:15 242:8,9 261:3
modeler 11:14
models 36:15 37:21 38:2,6 90:4 192:11
modern 59:2,14
modify 248:13 275:1 288:2
modular 134:10
molecules 123:3
moment 41:22 206:11 306:8,9 360:3
momentum 295:15 347:15,19 360:15
Monaco 1:11
Monday 19:16 92:6 326:6
money 76:14 198:18 199:3,7,10 216:20 217:1 218:7,8 240:21 249:9 287:5
monitor 235:21 259:8
monitored 303:19
monitoring 191:19 324:2
month 30:15 85:6 141:19 187:5 210:18 210:20 211:1,2 309:1 309:2,6,16 310:20,22 311:7 326:9 347:1 366:15 383:3
monthly 138:7 168:3,4 168:9 186:12 210:16 210:17,21 211:13 287:4 310:18 382:21
months 28:18 31:3 32:12 59:17 216:16 292:21 300:16,17 315:5 316:1 340:21
mooched 26:19
morning 4:3,12 5:8 6:8 9:5 13:20 14:18 90:2 92:6 212:2 309:14 338:21
motion 373:21
mountains 250:11 251:4
mounts 135:2
MOUs 241:19
mouth 26:7 216:20
move 37:6 69:21 71:13 91:4,6 93:14 144:17 160:8 169:1 171:4,16 172:14 173:2 214:7 258:8,16 260:13 268:20,22 270:19 271:5,13 272:19 279:17 294:14 300:6 368:5 378:9
moved 144:22 340:1
movement 215:9 265:21 358:3
movements 73:9 106:16 191:20
moves 175:2 267:13 268:13 271:13 304:22
moving 64:5,14 71:21 73:10 87:3 109:6,7 112:9 122:4,6 153:9 168:2 174:16 175:16 214:11 219:17 222:16 268:2 283:5 332:14 360:15
mud 33:6
multi-beam 259:6
multibeam 28:9 43:9 51:11 53:1 54:20 55:11 56:1 58:2 62:13 115:19 116:15,17 164:8,9,17 199:17,18 199:19 292:12
multibeams 58:16,20
multiple 38:2 125:17

143:10,12,19 144:10 227:1 228:22 229:1,1 245:15 249:11 257:18 374:6
Murray 339:12,13
Murray's 340:7
museum 217:12
mushes 151:15
mushy 273:11
mutual 375:20

N

nail 156:2
name 4:19 94:2,4 254:11
names 339:5
naming 269:6
nanometers 138:3,4
NANOOS 9:13 12:1
nanosecond 130:18
napkin 219:21
nation 249:2 250:7,8,16 250:18 251:6 338:3
nation's 251:13 273:4,8 335:8
national 1:3 2:3 54:15 57:1,3 72:18 87:9 227:3 246:16 248:18 248:18 249:19,21 254:1 256:4 272:17 273:5 279:15 282:12 289:3 302:22 311:17 312:21 314:11 324:18 340:22 341:3 345:9 346:15 348:6 353:8 355:2 361:7 372:4
natural 347:18
naturally 371:21
Nature 253:4
nautical 84:15 152:19 164:6 169:13,15 172:10,13 242:15 245:15 246:12 255:11 273:5,8
Nautilus 173:6
nav 6:8,11 60:22 299:13
navigate 47:11,13 195:5
navigating 44:6 49:8 59:18 181:16 182:5 275:19 286:8
navigation 2:13 7:5 8:6 19:19 40:14,15 43:6 49:9 51:6 65:11 83:4 109:22 111:1,16 112:10 170:3,15 172:3 176:15 177:13 186:14 190:3,10 198:20 203:1 205:17 208:14 209:14 219:1 230:7 234:14 238:19 239:3,5,6 243:21 275:13 281:11 282:5 282:17 283:16 286:13 290:18 299:14 314:13 314:14,18 316:15,18 317:3 342:3 357:21
navigational 85:13,18 85:20 96:18 176:4,11 226:6
navigationally 228:6 229:6
NAVO 119:15 126:1
NAVOCEANO 62:16
NAVSEA 241:18,20
Navy 23:5 53:16 62:21 71:5 254:11 263:9
nay 260:22
NCOM 38:15
NCS2 179:20
ND:YAG 121:20
NDEP 250:5
NDOP 249:20
NDVI 149:14
near 37:10 121:17 250:13 324:5
near-term 318:5
neat 7:19 18:15 19:3
neater 298:20
necessarily 10:7 12:2 27:6 63:22 75:20 105:21 154:7 319:21 330:20 351:8 364:14
necessary 46:18 241:19 269:15 288:15 357:5 370:16,22
NEEA 253:14,15,18 363:9
needed 175:6 234:13 257:18 350:3
needs 8:2 27:5 62:22 84:16 104:15 109:12 111:19 112:3 136:7 151:1 158:15 184:7 188:4 189:16 237:8 249:2,3,4 251:19 268:21 269:11,18 271:3,10,12 273:22 275:13 277:8 281:17 282:4,4 290:21 297:17 304:19 306:13 308:14 314:15 315:22 316:6 332:11 350:5 350:22 371:1
nefarious 56:14
neglect 333:13
negotiate 264:5
Neil 170:6,8,9,10 172:20
Neil's 183:17
Nelson 175:21
net 26:5 32:21 53:13 233:8
Netherland's 105:17
Netherlands 99:22
network 96:6,7,7 106:17,20
networks 78:13 86:21 95:10,11 96:4
never 32:13 33:3 37:15 57:2 62:6 171:11 187:9 274:17 331:20
new 2:2,6 4:17 6:1,11 7:18 8:22 10:1,3,12 10:13 14:1 17:10 18:2 20:16 21:15 24:13 44:18,19 46:21 47:1 52:17 59:19 66:6 74:16 80:6,11 89:13 90:17 93:20 104:20 105:20 132:16 150:19 171:4 177:1 183:20 184:13 200:19 203:18 205:18 214:9 217:5,5 217:5 218:5,7 224:17 227:3 230:16,22 231:4 240:3,21 241:2 255:19 259:6 268:2 281:1 301:21 303:6 304:15 308:1,19 315:10,11,16,17 318:11 325:7 335:15 335:17 357:10,18 358:19 359:5 364:2,6 364:20 366:9 371:4 372:16 373:1 374:13 377:19 379:1
newbie 327:10
newcomer 324:7
newer 120:13 122:22 129:7 131:22 143:11 145:11
NEWMAN 2:17
news 328:10,12
NGS 2:10 9:20 141:8 162:18 176:20 333:13 335:6 336:16 358:1
nice 18:1,2 22:5 61:12 68:3 201:2 211:5 225:15 285:18 308:11 320:4 325:1
nicely 211:16
Nicky 32:6
night 30:10 99:7 206:8 301:17
nightmare 356:9
nine 32:12 205:10
NIS 180:1
nitrogen 32:2 33:7
NMSAC 361:7
no-brainer 307:18
NOAA's 24:1 35:22 212:7 260:18 278:16 282:22 362:13 379:19
NOAA/NGS 2:11
NOAA/NOS 2:19
NOAA/University 2:1,5
Nobel 33:12
noise 129:20 130:13 328:15
nominal 162:3
nominally 225:9
non- 160:21 252:22
non-depth 161:10
non-digital 41:7
non-NOAA 246:11 255:10 319:12
non-voting 2:1 328:5
normal 37:8 200:7 339:4
normalized 148:2
North 80:7
northern 102:3
Northwest 5:17
NOS 2:3,5,9,12 301:21 306:17
NOSC 362:8
NOSIA 242:9
note 111:5 247:10 295:21
noted 333:12
notes 85:10 88:8 301:17 305:18 327:5
notice 41:16 341:14
noticed 219:15
noting 46:6
November 31:2
nowadays 121:21 125:12 149:11
nowCAST 24:1,3
NowCOAST 24:4,5,7,14 44:19,21 177:3
NRC 247:17 249:1 255:19 256:3,4 260:19 262:15 268:13
NRTs 334:5
NSPS 371:18 372:3
nuance 278:9 330:2
number 17:7 18:11 20:12 25:5 38:1 63:8 69:18 76:22 85:20 96:13 110:1 138:8

160:1 161:5,9,12 162:3 168:8 221:11 223:2 230:12 236:19 242:3 250:5 284:4 308:7 322:10 357:9 361:12
numbers 34:12 162:12 162:14
numerous 194:3
nurturing 57:22
Nyberg 179:18

O

o'clock 95:14
OBE 270:14
object 116:11 150:10 150:18 151:1,18 152:2,7,13,21,22 153:4,9 246:21 260:3 275:18 278:1 289:11 290:9,17 291:20 293:1 297:11 299:21
objectives 363:10
objects 47:20 75:4 78:17 79:1 81:18 82:13,18 153:2 288:14 289:14
observation 357:21
observing 362:5,7,10 362:11,12
obstructions 292:12
obvious 57:18,21 94:8 94:9 125:4 152:11,16 201:2 306:9
obviously 51:10 73:4 84:13 88:18 93:2 98:2 140:8 157:14 200:17 209:5 304:22 320:14 381:22
occur 36:18,18 106:18
ocean 3:5 16:22 17:14 38:3 155:8 168:20 185:10 203:8 242:15 242:22 250:12,13 251:4 252:12 261:9 262:20 265:5 326:5 362:4 374:15
OceanAero 4:20
OCEANIC 1:3
oceanographic 2:4 29:8
oceanography 9:1 39:16
Oceans 268:14
OCS 2:18
October 31:2 240:7
offer 53:20 218:13 301:1 363:1
office 2:8 22:11 28:20 153:16 270:10
officer 7:3 54:3
Officers 54:7
offices 8:1 42:12 88:15 242:20 304:10 319:15 344:20 362:11
official 2:8 374:12
oil 28:6 29:3,5 30:3 32:21 44:13 200:8,16
oil-laden 39:5
Okeanos 27:11 173:19
old 10:13 24:8,12 48:15 62:5 64:13 65:11,11 79:13 114:16,17 221:21
older 44:3 121:19 122:19 129:21 130:10 143:14 151:4,12
OMAO 240:9,11 242:7
ombudsman 260:20
onboard 174:1,1 179:4 356:11
once 7:10 30:1 32:19 51:16,17 53:8 57:8 85:21 102:17 105:3 111:22 140:21 148:1 206:15 228:20 229:9 256:8 309:1 324:13 347:12 351:22
one-pager 378:8
one-pagers 205:4
one-stop 72:19
ones 9:6,15 100:10 231:16 284:20,21,21 316:8,22 322:16 342:12 378:7
online 86:6 119:13
onus 329:11
op 325:20
open 26:7 49:18 59:11 107:11 110:8 248:15 315:17
opening 362:20
openness 321:21
operate 46:19 101:18 140:1 160:2 250:22
operates 83:6 89:3
operating 117:3 133:16 162:5
operation 93:14 94:20 305:22 362:12
operational 2:4 76:15 76:16 115:16 121:14 140:22 142:9
operationalize 65:6
operationally 65:14 135:13
operations 2:16 5:21 83:7 85:9,15 325:12
operator 135:1
opinion 159:3 160:6
opinions 202:20
opportunities 11:20 20:5 93:21 96:14 375:22
opportunity 13:10 16:15 64:15 72:11 96:11 268:19 309:11
opposed 20:20 374:3,7 374:9
opposes 310:13
opposite 8:16
Optech 120:14
optic 165:14
optimal 314:14
optimism 242:2
optimistic 243:1
optimization 40:2
optimum 157:22 284:14
option 354:12
options 350:12
order 94:5 111:19 131:17 132:10,10,15 152:20,20,22 192:3,4 206:10 240:16 274:17 285:5 286:9,19 287:16 297:11 299:20 317:9
organization 10:19 77:18 78:7,8 79:20 89:21 93:19 97:14
organizational 283:10
organizations 36:11 52:14 75:19 101:13 101:14,18 141:14 239:21 253:1
organize 87:16
organized 178:14 324:11
original 203:15,16 237:15 244:11 274:1 277:11
originally 221:18
ortho 249:19
orthometric 161:21
Orthophoto 249:20
other's 357:4
ought 211:21 265:8 308:16 309:4,4
outcome 284:13 285:10 297:13,14
outcome-based 284:12
outcomes 196:12
outgoing 126:19
outline 338:20
outlined 377:15
output 226:11
outside 15:10 22:10,10 62:13 78:8 93:1 97:17 98:1 101:3 110:9,10 188:17 199:1 248:11 251:13 271:2 275:14 303:17 305:10 366:4
outstanding 214:3 245:22 331:5
overall 53:6 307:13 330:22 382:9
overcautious 265:13
overcome 285:4,14
overlays 7:20
overload 367:22
overlook 142:12
overly 265:3 267:8 268:16
overlying 11:7
overtaken 281:7
overused 379:12
overview 3:2 16:21,21 18:5 207:8
owner 58:19

P

P-R-O-C-E-E-D-I-N-G-S 4:1
P&E 211:5 245:8 331:11 332:4 342:9
P&O 6:1 325:20
p.m 213:3,4 299:4,5 309:2 383:22
pace 12:6 114:7
Pacific 2:14 5:17
page 42:18 112:4,11 192:13 204:12 206:1 209:15 333:9
pages 340:3 346:8
paid 249:10,10
pair 21:5 37:18
palatable 297:7
palmer 122:5
Panel 1:4,11 4:5 5:11 6:3 9:10 13:5 15:12 15:15,20 16:10 20:6 103:22 113:3,12,16 180:10 186:12 187:11 188:14,16 193:9 202:19 204:3 215:8 261:21 262:7,8 267:9 269:5,5,17,21 270:18 271:8 272:18 273:2 281:18 284:5,13 285:3,14 286:4 287:18 294:13 298:5 300:10 301:3,16

302:3 306:5 311:12 312:10 317:16 319:3 319:12,12 320:2 322:13,22 323:13 324:8 327:12 328:3 329:18 330:17 333:9 334:7 337:11,20 346:11 349:9,19 350:9,17,18 356:9,14 363:12 364:22 371:1 375:9
Panels 218:3 308:9 323:14,18 324:10 327:20 333:6
panorama 48:12
panoramas 48:10 49:3
panoramic 82:4
paper's 270:13
papers 3:17 6:7,15 21:19 39:21 167:11 190:1,8 193:6,8,10,13 202:16,17 203:22 205:3,9,10 206:5 209:6 211:18,19 212:15 214:2,9,11 243:16,18 244:5 245:5 246:5 292:20 293:2,17 299:11,14 300:15 301:11 309:9 310:4,9 311:11,15 312:8 318:16 319:7 321:15 326:4 337:17 338:5 342:15 347:18 350:4 351:4 360:7,8 363:15 369:17 376:2 376:13 377:3,8 379:1 379:2,9
paradigm 90:14 101:18 157:1,11
paragraph 345:7 352:10
Paris 1:11
parking 370:15
part 13:22 14:2,10 15:8 25:12 29:15 33:1 42:22 54:18 55:17 56:22 59:9,15 63:11 63:11 64:17 70:17 79:22 83:18 89:17 93:10 97:2 98:18 104:6 109:22 156:15 161:10 162:8 170:22 175:17 189:22 193:1 193:5 194:11 197:18 210:10 215:12 216:12 227:20 249:4 257:8 260:15 261:19 273:2 275:22 294:8 295:21 318:22 336:14 351:1 360:21 370:1,17 374:17
partial 279:20
partially 261:4,4,5
PARTICIPANT 32:17 37:9 65:15 110:19 165:20 174:9 195:1 308:5 334:19 335:15 342:11 353:18 359:12
participate 309:21
participation 311:9
particular 8:15 22:22 23:8,14 44:11 74:12 80:4 83:21 84:3,5 106:13 170:20 176:6 222:2 258:3 285:17 320:1
particularly 21:7 59:6 200:9 219:14 225:2 225:22 253:15 259:5 326:4
parties 104:21
partner 343:12
partners 262:4
partnership 225:7 365:18
partnerships 201:12 320:10 366:8
parts 84:13 220:14
party 252:14
pass 118:17 125:18,21 143:1,17 144:10 153:6 282:21 322:3
passage 86:13
passing 144:14,15
passive 137:13
patched 111:6
patches 164:8
pattern 125:11,13 126:7
patterns 77:16 94:8 125:9
pay 164:3 194:2 217:3 276:16 309:18
payer 199:5
PDF 178:9
Pelagos 132:3
pending 272:7
penetrate 122:16 136:4 138:6,20 140:12,13 144:11 158:14
penetration 136:12 144:20
Penobscot 178:19 179:12
people 6:10 7:8 9:11 11:15,22,22 12:1 14:5 14:14 16:6 18:19,19 19:6,11 20:14 31:11 31:12 43:20 47:22 50:2 51:5 54:21 56:3 61:5,13 65:8 70:15 72:4 74:12,14 78:3 91:9 94:5 108:6 127:15 160:1,12 162:15 168:15 173:22 185:12 199:3 238:8,9 239:18 244:15 260:12 261:10,17 271:3 273:6 280:17 298:7 304:16 305:4 307:16 309:8,8 315:8 316:19 318:14,21 321:5,10 324:15 327:22 333:15 334:10 336:7,17 349:8 353:3,22 355:6 356:11 358:13 365:22 366:7 367:4 373:7 376:21 378:10 380:15 383:7
people's 278:17
perceive 19:7
percent 51:11 153:5,10 161:5 163:12 238:17 240:18,19 355:3,3
perfect 58:7 188:4
perfection 326:16
perfectly 62:7 156:1
performance 348:6
performed 276:16
period 3:12 74:18 207:20 289:22 366:22
periscope 23:9
PERKINS 1:18 6:18 101:20 156:22 302:7 337:2,5 339:15 343:14 347:3 357:16
permits 107:6 142:7
person 53:22 60:19 104:15 292:22 304:6
personal 89:13
personnel 44:14
perspective 35:13 47:11,14 54:15 60:3,5 63:5 73:3 96:6 258:13 269:17
pertain 308:21
petty 278:6
phased 220:20
phases 256:15
PhD 17:17
PHELPS 2:18
phenomenal 376:13
phone 33:22 89:15 295:5 300:2 352:1 382:21 383:2
phones 294:3
photo 82:12
photograph 150:4
photon 157:3,13
photos 82:4,5 249:19
phrase 307:6
physical 14:15 97:3
physically 73:19 126:13
physics 33:13
pick 128:4 156:9 162:11 208:9 227:21
picked 24:1 28:13 148:10
picking 35:14
picture 30:8 38:11 47:1 53:6,12 56:16,19 60:8 80:3 91:15 92:18 116:21 233:9
pictures 56:12 95:9 202:12
piece 32:21 374:13 381:7
piecemeal 111:5
pieces 32:22 269:7 359:17
pier 107:13,15 316:3,4
piers 111:13 112:8
pile 252:2
piling 146:3
pilot 40:18,19 41:12 45:21 59:1,5,10,15 63:18 67:20 68:2 98:17 108:1 171:9 184:4,13,16 185:9,13 221:19 224:2 329:5 365:5
PilotMate 221:19
pilots 74:13 98:17,19 99:2 100:15 108:5 219:15 220:10 221:16 221:18 224:11
pinkish 146:16
pioneering 84:1 251:22
pipeline 208:7,13
pipelines 79:6 155:4 208:17
pitch 25:13 201:4 202:2
place 37:14 46:7 88:10 109:5,15 115:10 155:2 159:18,19 160:12 332:10
places 52:22 99:19 213:17 272:2 274:6
plain 114:6
plan 39:11,22 45:10 76:17,18 80:4 83:2 86:12 139:18 187:3 227:3 240:4,6,8,13

302:22 311:18 312:21 314:11 324:18 337:14 340:22 341:3 342:22 347:21 348:1,6,17 353:8 355:2
planar 82:1
plane 122:6 139:7,15 335:21 380:6 381:1
planning 3:16 36:20 39:9 45:9,12 74:17 75:1 85:8 86:10 92:11 93:16 96:5 106:12 156:2 187:8 193:3,4 193:14,20 308:22 312:1 350:2 353:21
plans 180:3 343:9,13
plant 371:9
platform 42:9 72:20
platforms 42:4 159:4
play 69:12 240:22 279:4
player 249:3
players 78:10 305:10
please 42:13 112:17 113:1 160:9 169:21 169:22 193:14 210:21 293:2 299:2 349:17 362:1
pleased 223:21
plenty 16:1 116:18 214:7 379:6
plotting 65:13
plume 29:7,10,21 30:3 38:7 39:3
plural 372:11
plus 64:13 83:10 85:5 160:18 190:12 233:11 234:12
poacher 53:11
pocket 24:11 266:14
pod 171:7
point 7:13 11:12 15:21 22:20 45:13 54:10 58:10 67:7 86:14 101:5 106:3 107:17 109:18 114:10 142:8 142:20 143:3 145:1,5 145:6 148:14 150:4,8 182:8 198:7 205:2,3,7 207:22 208:2,19 210:3 211:12 225:6,6 234:5 240:20 241:5 241:10 243:7,14 244:19 257:13 258:12 258:22 265:4,14 266:2 274:1 287:9 290:16 292:17 354:3 357:11 365:20 367:3 371:11 375:15
pointing 37:13 365:19
points 5:12 6:5 8:3 10:16 122:6 143:4 163:19 165:5,7 214:22 243:8 294:16 301:1 381:6
Pokemon 60:18,18
Poland 95:21
pole 38:16,18,18
policy 2:12 28:21 194:19 250:3,18 272:8 280:22 303:6 322:4 343:21 380:10
political 308:6 366:7
polyline 223:12
pony 329:3
poor 222:19
portable 67:20 68:2 98:17 108:4 164:15 171:6 221:19 224:2
portal 77:11
portfolio 362:10
portion 156:14 252:11 252:12
portrayal 23:5
ports 3:7 71:21 72:13 73:6 75:19 76:5 81:7 87:22 89:4 96:6,12 97:4,17 100:9 102:7,9 102:15 103:5,6,12,21 111:20 112:5 216:11 232:16 316:7,7,22 365:19
Portsmouth 44:12 45:4 48:11
position 111:13,14 174:8 304:20 365:15
positioned 7:6 112:8
positioning 357:19,21
positive 373:3
possibility 377:6
possible 19:8 22:12 149:5 158:18 248:2 259:13 268:7 346:8 354:8 359:8
post-work 349:9
postage 225:16
posting 247:3
potential 12:10 262:22 263:9 265:6 318:13
potentially 44:13 54:5 158:19 176:14 203:4 263:18 285:12 344:14 344:16
power 120:8,21 121:1 127:10 133:22 135:8 135:12 139:9 191:18
powerful 12:11 69:1
372:1
PowerPoint 166:7
PPU 329:6
PPUs 68:11
practical 8:8 117:7
practicality 50:13
practice 46:14 303:15
praise 382:19
praises 7:8
praising 333:5
pre- 350:19
pre-position 357:20
preaching 277:16
precipitous 265:14
precise 172:3 176:15 203:1 238:19 239:3 314:13,18 316:15 317:3
precision 6:8,11 111:1 111:15,20 112:10 170:3,15 177:13 186:14 190:3,10 192:15 205:16 209:13 218:22 230:6 243:21 299:12 342:3
predictable 116:4
prediction 90:4 94:15
predictions 45:2 177:4
predicts 82:22
prefer 216:1
preferably 247:4
preliminary 153:21 301:1
prep 153:18 154:22 155:8
preparation 155:7 360:20 361:14
prepare 93:12 315:5 376:9
prepared 8:21 241:21 293:7 294:5 325:13 339:16 358:10
preparedness 340:9
prescribed 246:22 290:9
prescriptive 267:8 268:16
present 1:13 2:7 15:1 72:2,8 170:6,8 171:18 171:19 177:20 187:4 257:14 320:2
presentation 14:20 17:11 18:2 43:6 71:14 110:16 170:19,22 187:22 194:1 210:9 301:20 302:13 322:8 330:11 337:6 345:14 358:15 363:8 367:10
368:11 375:17
presentations 14:19 111:2 170:13 177:21 185:19 186:10 201:9 201:10 329:10 334:6 358:16 359:2 362:21
presented 145:13 169:6 169:18 170:11 171:20 172:4 174:12 175:21 176:19 177:6 178:20 201:8,8 228:18 320:13 357:18
presenter 110:13
presenters 3:3 369:19
presenting 16:4
presents 181:20
Preservation 54:3,7
President's 346:3
presiding 1:12
press 60:17 372:21,22 373:6
pressing 271:7
pressure 352:2
presume 50:12
pretty 7:19 13:6 114:16 116:10 133:5,20 134:8 141:11 145:12 146:3 154:3 156:16 163:13 191:16 202:12 208:10 221:11 241:15 251:21 327:13 339:21 348:18 359:4
prevalent 101:21 102:4 139:19
prevent 310:3,7
previous 113:5
primary 49:14
prime 205:15
Princess 5:22 325:19
principles 18:22
printed 40:19
prior 111:11
priori 191:15
priorities 242:18 301:21 328:18,19 346:15 347:12
prioritize 332:8
prioritizing 361:4
priority 341:8 345:10 376:11
private 12:19 103:19 111:10 208:22 209:2 253:3 362:20 365:18 366:8
Prize 366:14
probably 7:8 34:6,11 42:21 52:3 53:22 105:21 106:6 115:5

134:5 140:15 160:5 166:12 184:7 211:15 219:1 228:2 238:2 244:21 249:4 251:16 263:13 305:19 315:3 315:7 316:7 317:1 323:8 326:9 346:20 355:2 372:7 379:10
problem 29:1,2 36:8 52:21 107:20 128:6,9 129:8 158:11 159:22 162:8 194:5 197:8 226:13 256:10 286:21 292:14 334:3
problems 72:19 151:12 225:14 288:8 325:2
procedure 109:22 347:2
procedures 297:9 299:18 354:21
proceeding 241:12
process 45:12 67:11,19 69:19 84:22 85:17 99:14 107:20 108:1 198:11 206:10 246:11 255:10 260:16 269:12 269:14 279:22 288:18 288:20 293:17,21 314:20 346:11 349:3 349:17 352:22 359:20 360:6 377:7
processes 79:18 87:4 95:3 308:22
processing 33:16 181:10 206:20 303:13
procure 240:17
produce 171:8 214:14 237:19 245:16 305:10
produced 7:22 239:22 244:9
producing 109:14 232:2,5 249:5 250:17 259:19 338:2
product 101:13 104:15 107:20 172:14 214:15 229:7 235:21 259:18 259:20 354:17
product-centric 182:9
production 109:13,15
products 2:4 64:8 68:1 109:16 171:9 182:1 182:19 184:22 196:13 206:18 209:6,20 215:19 221:15 230:3 230:8,22 232:2 253:21 254:3 336:17 338:2
professional 365:14
372:5 375:13
profile 365:9
program 2:18 17:14,15 17:17,18,18 72:7 87:8 118:20 221:9 240:10 241:14 243:1 249:20 249:21,22 252:4
programs 250:1
progress 42:17 179:19 197:19 282:7 285:9 326:22 347:17
progressed 118:2 119:8 126:4
project 2:21 15:4 69:4 104:3,4,6,9 128:2 146:7,8 149:9 184:11 219:7,10 222:5 224:13 225:10,12 257:6,8,14 258:13,16 259:3,7
project's 104:10 259:22
projects 111:16 218:7 256:21 257:15,15 349:8
promoting 160:16
propel 328:7
proper 39:6 60:21 244:16 248:6 354:14 354:21
properly 259:21
properties 39:4,7
proponent 283:19 326:16
proponents 328:11
proposal 270:18
propose 363:11
proposed 303:22
proposing 210:7
proprietorship 273:14
protect 53:7 82:14
protected 88:16
protection 10:13 59:20 185:14
protocol 354:15
prototype 40:20 44:19 175:22 220:12
prototypes 109:11
proud 7:15 45:18,18,19 375:10
proved 254:18
proverbial 195:6 270:3
provide 53:6 55:7 63:10 64:8 66:1 98:13 109:15 224:22 227:7 230:4,8 235:7 240:12 271:19 282:20 353:8 362:21 378:11
provided 98:6,8,10,16
208:21 223:7 369:18
provider 98:13
providers 88:11 330:11 380:14
provides 116:3 335:7
providing 56:15 221:15 223:11,13 330:12 358:2
province 28:6
provocative 308:10
pseudo-3-dimension 37:18
pseudo-real 175:13
psychology 18:21
public 1:6 3:12 5:14 70:21 71:3 166:2,4 189:10 191:4 196:3 207:19,22 209:3 232:2 240:7 291:7 318:19 319:2,7 337:17,19 338:7 350:15 356:10 365:18 366:8 367:12 370:15 370:16
publicly 57:5
published 62:20 169:9
Puget 5:21 176:1 225:8 228:16 230:3 231:7 236:10 303:21
pull 31:6 134:17 137:9 186:2 212:5 376:17
pulled 31:16 146:13 220:8
pulse 118:8 121:2 123:14 126:10,19,21 127:10,19
pulses 118:22
purchase 240:19
Purely 149:16
purpose 27:8 123:13 134:7 149:8 176:6 199:19 202:8 242:17
purposes 92:11 117:20 152:19 355:20
pursue 111:15
push 19:17,17,17 68:12 68:20 107:22 108:3 110:6 162:18,18,20 353:3
pushed 67:14 371:21 376:1
pushing 56:7 67:22 103:6 112:4 231:7
put 24:14 27:11 30:17 31:1,9,13,22 33:4,6 33:19 36:3 37:18 38:19 48:3 49:4 51:13 51:17 53:13 65:7
66:11 80:15 88:10 107:4,5,10,19 118:4 129:16 164:16 167:14 167:19 178:6,9,15 193:6 198:3 199:21 209:8 228:4 235:15 236:20 240:18,20 257:9 272:12,14 274:3 280:5 285:20 288:20 301:16 303:14 314:6 320:21 339:17 362:16 376:12,21
puts 38:16 70:12 276:14
putting 25:10 29:17,17 29:19 57:9 81:8 121:1 141:17 155:3 164:18 184:16 325:2 329:11 361:13 362:19 382:20

Q

QC 163:19 164:4 172:13 175:20 230:18
QL 162:7
QL0 160:12
QL1 160:12 163:18
QL2 160:12 163:18 254:1
quality 160:11 163:8 172:4 261:8 273:17 308:8
quarter 192:5 207:20
quasi 23:7
quay 76:15,15 80:11 82:8,9,13 83:1
question 31:10 53:4 64:21,22 65:5,21 68:19 70:1 93:14 98:3 156:21 177:17 179:2 189:9 191:6 206:2,5 210:16 225:6 231:11 231:17,18,22 232:13 233:22 236:5 237:15 280:7 296:19 303:11 329:17,21 339:4 349:2 372:10 377:2
questions 33:14 49:22 50:3 110:9 113:17 150:11,16 160:8 189:1,10 191:3 231:10 243:3
quick 71:8 180:2 295:21 299:10 361:18
quickly 52:1 71:5 169:2 169:22 189:9 230:22 240:12 260:17,21 301:15 347:18
quite 25:19 28:13 35:7

37:12 44:22 63:2 67:6 74:11 146:9 147:6 178:13 185:19 187:11 252:5 256:14 272:7 325:10,13,21 328:1 346:6 367:14 376:3

R

R 1:18
R&D 3:5 15:2 174:10,11
Rachel 2:15 153:14,15 153:16 179:1
radar 61:7
radioactive 39:3
rail 106:4 215:20 216:2
rain 140:2,2,5
raining 140:1
raise 210:4 217:7
raised 308:10
Raman 122:20 123:16
ramifications 30:6 54:11
ramp 58:7
ran 27:14
range 11:19 22:6 50:15 52:3,5 148:10 223:19
ranges 148:7
rank 352:6
ransom 111:5
rapids 140:18
Rassello 1:19 23:16 99:12 106:22 108:10 232:12,19,22 233:7 233:14,21 234:12 235:1,3,9,18 236:15 238:18 314:8,10 316:14 363:20 364:4 364:6
rate 127:2 335:5 353:1
rational 11:11
raw 147:9,15 148:14 226:1,11 326:6,18
reach 12:12 115:4 354:5 381:22
read 50:1 169:9 225:1 235:20 252:4 272:18 274:8 293:11 295:22 299:17 305:17 309:9 318:21 351:10,22
reading 256:20 317:16 360:17
reads 204:13 262:1 264:8 344:16
ready 94:10 239:9 243:15 281:19
real 10:9 45:8 47:2,18 47:19 49:1,1,2 59:10 59:13,17,17 60:14 68:3 86:20 101:11 142:21 145:4,5 148:8 175:1 181:9 197:6 212:11 267:12 291:22 292:7,14 299:10 322:14 326:16
real-time 184:16
realistic 60:8 168:10
reality 20:17,17 46:3,10 47:6,7 105:11 124:19 201:7
realize 24:10 180:11 200:1
realized 28:8 220:4
realizes 73:19
realm 41:18
realms 245:8
rear 2:7 144:15 213:20
reason 13:12 108:4 140:9 175:19 216:14 231:5 256:22 262:1 333:4 351:1 352:6 380:8
reasonable 64:4 168:12 289:22
reasons 58:12 170:19
rec 299:11 336:10
recall 150:19
recap 3:15 239:14 243:21 299:10
recapitalization 240:4
receive 231:3 355:4
received 303:3
receiver 334:22
receptive 225:3
reclaimed 80:7
recognize 291:6 320:17 321:2
recognized 242:21
recognizes 199:2
recognizing 303:2
recommend 261:21 263:4 269:13 287:15 336:3 354:22 357:16 376:20
recommendation 214:17 247:12,18 248:14 255:8,12 267:2 271:5 275:4,15 276:2 277:8,9,11 278:15 284:8,19 286:15 287:15 288:6 288:21 289:2 294:15 297:6,15 298:12 300:6,21 302:6,15 304:18 307:13 317:11 319:10 332:14 333:2 335:13 343:1 347:13 352:17 365:16 376:2
recommendations 167:21 213:21 246:5 246:9 247:6,22 248:12 261:22 267:4 274:5 284:6,12 296:10 300:13 305:21 310:17 313:12,18 340:4,16 342:17 366:5
recommended 366:11
recommending 266:1 310:12
recommends 201:5
recon 153:18,21 156:17
reconnect 347:16
reconsider 205:12
reconvene 196:3 213:1
record 42:4 77:1,5 112:21 213:3 299:4 317:8 319:1,2,8 337:17,19,19 338:7 383:22
recording 25:16
recovered 25:13
recreation 340:10
recreational 6:12 60:3 145:22 171:9,10 185:2 203:2 244:1 247:11 303:8
rectangle 83:16
red 84:13 123:6 130:9 132:10 159:9
reduce 112:12 160:1
reducing 94:15 95:3 133:21,22
reduction 340:9
reef 37:5 117:9
reestablishing 241:13
refer 120:4 160:12 191:9
reference 167:20 183:10
referred 136:13 336:7
refill 37:7
refineries 80:14
reflectance 136:15 146:21 147:22
reflectivity 135:21
reflector 208:11
reflects 122:17 129:17
refresher 65:22
regard 100:21
regarding 107:22 256:17 314:20 366:19
Regardless 276:3
regime 22:19
region 10:11 130:15 184:14 188:12
regional 2:11 117:19 188:10 225:18 369:22
regionally 369:21
regular 48:15
regulation 55:9 71:9
regulations 259:19
reins 213:11
reiterate 68:8 345:16
relate 97:18 105:8
related 60:16 176:20 178:18 182:18 208:15 272:2 304:9
relations 5:16 94:1
relationship 96:19 296:6
relationships 94:8 224:8 258:3
relative 112:8 200:15 201:5 324:7
relatively 129:13 149:18
release 57:16 60:17
released 54:5 208:5 240:6,14 258:15
relevance 201:21
relevant 17:8 18:14 19:19
relief 31:1
relies 60:13 63:12 64:2
relieve 71:9
relying 252:20
remainder 337:3
remaining 6:14
remains 254:4 379:10
remake 275:5
remarkably 18:14
Remarks 3:19
remember 104:19 145:18
remote 2:10 117:9 142:5
remove 348:11
repair 107:20
repeat 191:11,20 244:4 287:20
repeatability 191:13,22 192:9,13
repetition 118:9
repetitive 182:22
replace 292:11
replaced 88:5 291:19
replacing 85:9
replay 25:17 92:16
replicate 188:20
report 88:8 97:2 208:7 239:22 255:20 317:22 319:14 349:4,12

365:3 369:8
reported 208:11
reporting 30:14
reports 300:11 318:10 319:5,6 337:18 379:5
representative 362:5
representatives 254:12 339:6
request 15:14 265:15 313:8 319:11 353:7 364:21 373:14
requested 113:8
requesting 337:11
require 152:21,22 206:20 377:17
required 135:8
requirement 108:8
requirements 133:22 172:10 242:10,11 363:9
requires 111:20 139:9
research 16:12 18:12 20:9 28:12 46:21,21 177:7 197:8,15 248:19
researchers 254:11
reserve 338:11
resolution 43:13 48:9 50:21,22 51:14 53:1 54:1 98:4 222:12 223:5 232:6 251:3
resolve 33:3 153:7 250:3,18 292:18 360:13
resolved 32:2
resonate 306:12 345:2
resonated 306:7
resource 203:19
respect 57:3
respectful 357:4
respectfully 302:7
respective 380:7
respond 180:20 181:5 260:16,21 321:9 357:2
responded 375:11
responds 301:7
response 7:5 44:13 55:4 87:10 129:21 130:1,7,11,13,19,20 265:20 313:6 348:16
responsibilities 103:13
responsibility 53:7,14 56:8,9 100:2,10,18 102:12 103:18 238:10 259:19 276:9,10,13 284:18 313:2
responsible 101:22
responsibly 362:9
rest 218:14 312:10 323:1 350:6 369:9
restrain 239:3
restricted 55:20 57:19 203:11
restrictions 86:17 142:6
result 106:16 253:20 284:15
results 6:17 227:13
resumed 112:21 213:3 299:4
retain 76:1
retrieve 92:14
return 35:10 122:10,14 122:21 123:8,12,16 123:16,18,18 124:12 124:14,17,18,19,21 125:2,7 126:12,19 128:14,15 129:14,15 130:8,22 136:19 140:2 143:15,16 146:20 147:13 152:13 157:17 158:6,6,14 243:9
returned 123:5
returning 34:18
returns 125:5 126:9,14 126:21 129:4 143:12 143:13,19
reuse 346:4
revenue 76:17 84:9 200:15
review 1:4,11 3:10,19 4:5 168:21 169:8 193:10 204:3 205:3 207:16 230:5 239:15 246:10,10 247:8,19 247:22 248:3,7,14 251:20 255:4,9,9 256:21 257:1 260:15 262:7,14,14 263:22 264:9,22 265:5,16 266:1,21 267:3 269:12,14 279:22,22 281:18 282:8 283:7 290:12 293:1,3,3 299:13,15 300:17 310:3 312:20 326:7 326:20 340:18 346:21 348:4,19 353:7
reviewed 6:6 342:7
reviewers 260:11
reviewing 175:4 311:17
revised 299:15
revisit 247:17
revolutionary 69:10
rewrite 6:9,21 342:2
RGB 148:9
RICE 2:19
rich 2:4 28:6 176:21 306:21 307:20 328:5 369:5,10
Richard 365:19
richly 382:19
Rick 2:12 4:9 19:10 45:14,15,17 53:21 64:22 65:15 69:2 103:11 170:7 171:18 171:20 172:3 190:2 209:8,8 263:2 287:12 289:9 292:15 363:7 369:17
Rick's 69:14,20 183:17
rid 202:11
ride 380:6 381:1
Riegl 121:12 131:10 162:19
right-hand 201:13
rigorous 213:14
rigs 35:19
risk 317:7 340:9
river 83:9 117:8 140:18 142:18 143:9 150:2 164:13
rivers 154:12
RMSE 133:2,3 161:4,7
RNC 182:19
road 95:15 106:4,17,19
roadblock 285:2,14
roadmap 290:21,22 291:2
roads 335:9
robust 35:4 213:15 340:13
rock 146:3
rocks 150:21
ROIs 320:14
role 74:12 102:11 180:12 267:9 331:7 358:1 379:19
ROLIN 2:16
roll 25:13 213:5 337:12 364:5 383:16
room 18:3 94:5,6 105:10 193:11 216:22 321:6 335:20 355:1,5 381:1 382:14,14
root 132:20 160:17
rooting 59:8
roots 59:7 200:18
rope 137:10
Rose 15:20
Rotterdam 15:3 72:4,8 72:14 73:6,15 75:6 76:4,13 77:19 78:4 79:2,19 80:8 83:5,6 85:13 91:15 94:22 95:6,20 97:10 99:12 100:1,1 107:14 111:3
roughly 127:22
round 376:14,20
rounded 34:15
route 39:11,22 45:10 86:10,14 208:18
ROV 31:22 33:4,19 34:16
ROVs 32:11 33:6
row 171:19
rudimentary 105:22 149:7
rules 60:22 228:19,21 229:10 350:16 355:13
ruling 295:22
run 30:22 32:5 41:21 102:5 119:14,15 121:11,13 139:10,20 149:11 188:5 229:12 264:15 294:19 335:21 379:17
running 38:15 45:5 46:14 53:12 118:14 118:15 134:5 138:18 157:15 173:21,22 191:11 240:5 248:1 325:21
runs 92:15 120:11 121:12
rushed 370:5
RUSSELL 2:9
rut 71:2

S

S 196:17
S-52 236:2
S-57 223:7,14 236:1 237:3
S57 67:9 109:5
Saade 1:19 3:3,14 12:18 13:3 34:4 57:12 69:21 115:11 156:7 159:3 179:1,14 181:2 187:19 188:22 189:11 189:13,17,21 194:20 198:5 202:6,8 204:17 210:11,15 211:3,10 211:14 254:6 261:2 310:21 320:9 366:13
sadly 371:3
safe 86:13,13 156:18 198:20 234:14 235:11 235:11 239:5 253:10 340:8 383:17

safety 8:5 10:8,12 59:20 117:3 127:15 185:13 234:18,19,20 238:20,22 316:17,19
sail 66:13
sailing 238:21
Sal 7:17 19:20 64:9 106:21 170:16 231:16 237:7 316:13
sale 74:15
sales 81:16
salient 270:13
Sally 99:6
SALVATORE 1:19
Sam 26:7 64:18,20 337:9
Sam's 68:19 70:1
Samoa 173:20
San 4:21 27:13 304:2
sanctuaries 54:8
sanctuary 54:8
sand 20:2 25:22
Sandy 37:1,4 52:17
sat 183:16
satellite 90:18,20 100:15 137:22 154:10 155:10 179:2
satellite-derived 153:20
satisfied 261:8,9
satisfying 108:7 237:14
saucer 334:20
save 94:18 382:5
saver 35:13
saw 10:11,20,20 15:20 31:14,14 32:1 38:20 38:22 55:22 63:10 78:21 90:2 181:7 190:16 196:12 221:2 253:20 326:19 358:17
saying 33:2,22 34:8 56:8 64:3 69:14 157:15 167:18 266:19 266:20 271:9 275:17 280:6 282:3,3 287:12 288:11 290:12 297:22 306:14 356:2 361:2 369:2,6
says 62:22 288:7 289:21 297:18
scalability 50:8,14,19
scale 50:15 51:20 225:13,18 227:1,2,6 227:10 228:13 234:6
scaled 202:11
scaler 192:1
scales 227:1 236:8
SCALGO 226:20
scaling 225:13 232:13 232:16 233:22
scamax 237:2
scamin 237:2
scan 125:12 126:7 143:10 144:13,14,15
scanned 46:22
scanner 122:4,5 143:19 172:11
scanning 125:9,11
scariest 30:11
scarp 28:4
scary 31:10 61:11
scatter 124:5 155:5 199:17
scattering 124:4
schedule 88:20 211:8 298:22 354:4
scheduled 110:12
schedules 104:22 105:1 353:3
school 25:21 26:4 53:12 108:21
schools 54:20 55:12,17 56:2
science 17:14 18:20 28:20 39:14 379:19
sciences 92:21
scientists 55:4
scope 273:9,20 322:11 356:12,13
scoping 252:10
Score 239:14
Scott 1:18 156:21 205:11 206:9 302:6 318:22 356:19 381:18
scratch 32:13
screen 46:18 54:6 60:9 235:11
SCRIPPS 220:15
se 92:2
sea 24:18,21 25:3 27:12 33:8 35:6 37:7 43:3 47:4 51:3 54:22 55:2 70:10,18 80:7 103:9 107:11 121:4 122:8 122:12,15,18,20 123:3,7,9,14 137:8 140:3,11,14 183:7 290:8 324:2
seabed 124:6 126:16 129:2,17 135:21 138:21 146:21 147:1 147:1,16,22 148:18 155:4 157:18 320:19 364:16 366:13
seafloor 116:22 122:11 136:14,17 138:16 151:11,16 158:8 191:10 195:2 246:21
seagrass 147:3,4 148:8 148:11,18,20,21
seamless 142:22 143:6 185:8 250:10 251:2
seamlessly 336:9
seaports 216:12
Seas 226:22
seasick 48:1
season 138:9 149:4 155:15,16,17
seasonal 138:10
seat 18:2
seats 113:2
Seattle 1:12 4:5 5:2 6:2 7:8 95:12 217:14 331:17 339:4,22
Sebourn 325:19
Secchi 136:21 137:5,6 137:11,12,15,16,20
secede 381:19
second 11:18 32:10 34:2 118:22 126:11 173:4 241:1 245:12 290:20 305:15 360:19 362:3 363:14 374:2
seconds 144:14 215:10 383:4
Secret/NOFORN 53:16
Secretary 30:12,13 33:12,12,21 34:12,21
Secretary's 34:8
section 148:16
sector 208:22 209:2 239:20 291:7 340:6
sectors 185:11
secure 88:16
security 54:15 57:1,3 87:8 106:9 361:8
sediment 36:15 138:19 155:1,9
sedimentation 83:10
sediments 138:15
seed 371:9
seeing 32:15 44:1,16 45:5 46:5 60:15 65:4 97:21 101:17 103:7 143:10 144:10,21 151:17 169:19 177:10 325:6 347:13 371:20
seen 13:12,15 56:19 69:8,9 87:7 89:2 156:22 157:8 167:9 167:16 169:3 254:5 265:19 267:11 306:3 315:15 325:12 327:12 345:12
seep 27:19 28:16 33:15 34:19 200:3,4,6 208:2 208:7
seeps 30:5 173:11 208:9
segmented 126:8
segments 184:19
select 233:3 234:17 316:7,22
selected 43:14 227:17 369:7
selecting 228:7
selection 227:16
selective 316:9 317:1
self-serving 337:22
Senate 199:4
senator 339:7,12,13 340:7 373:1
senators 373:7
send 19:7 89:16 126:10 175:12 293:2 347:6,8 350:8 358:7
sending 265:4 310:4
Senior 2:21
sense 36:14 51:18 60:7 71:22 105:20 113:18 171:13 242:2 248:9 305:17 367:21
Sensing 2:10
sensitive 28:8 32:15 54:12 117:9 203:14 204:2
sensor 25:14,14 86:21 118:15 121:11 123:6 126:3,3,9 128:1 132:13 133:18 134:1 134:2,5,8,10 135:1 137:13,14 141:3,4 142:11 143:2 146:10 148:5 162:11 165:10 165:11
sensors 3:9 117:22 118:12,14 120:1,2,4,5 120:7,8 121:9,12,13 121:15,16 125:8,11 126:3 127:7,17,22 129:5,7 131:1,8,14 132:1,5,7 136:20 137:3,4 143:11,14 145:12 149:11 151:12 162:13,16,19 163:7
sent 33:6 222:12 283:4
separate 171:3 196:13 245:5 287:11,14 290:15 360:9
September 17:21 205:18 310:6 363:6 377:20

sequence 30:17
serial 197:2 252:16
series 37:1
serve 123:13 382:11
served 134:7 336:10
serves 39:20
service 100:1 111:9 242:20 330:10 362:4 380:14 381:9
services 1:4,11 2:5,13 4:5 328:8 345:12,21 358:2
session 3:3,15 5:13,15 6:7 9:5 13:5 187:21 188:5 196:2 213:6 296:22 297:1 370:18
set 6:19 44:18 46:20 55:9 62:8 64:4 73:20 74:3 179:5 233:16 234:20 240:2,22 253:19 254:17 256:15 256:16 261:3 308:1 308:19 315:13 322:22 323:15 326:3 344:4 345:4 358:7 379:20
sets 51:18 52:16 53:5 57:4,9 75:21 111:4 156:8 315:21 325:1,3
setting 162:14 230:11 257:22 382:20,21
settings 174:2
settled 232:1
seven 37:1 126:13,14 126:21 226:22 239:1
seven-page 294:17
shallow 117:4,8 126:15 126:20 128:1,5,10,11 129:6 130:4,15 134:11,13,17 141:3 142:21 144:3 148:5,9 151:6 159:18 164:11 314:18
shallower 52:3 84:13 120:17 128:17
shallowest 143:16
shape 158:7 242:12 304:20
shapes 22:13
share 215:1 267:14
shared 296:1,14
sharing 87:20
sharper 296:8
sheet 298:19
Shep 2:7 181:5 182:15 201:8 245:1 247:20 248:13 263:3 266:12 266:18 270:9,17 271:4,22 274:21 282:7 288:7 297:17 306:10,13,21 310:9 322:13 339:21 341:20 348:15,19 349:12 369:10,17
Shep's 265:20 270:16 280:22 281:8 288:19 321:15
shift 90:13 101:17 157:1,11 182:7
SHINGLEDECKER 1:20 60:2 61:14 211:4 284:2 285:21 302:19 342:4 344:2,12 347:11 353:14,20
ship 10:15 32:19 55:15 59:12,13,18 62:14 64:10 65:7 66:12,22 70:17 73:8 84:2,4 85:4,5,7 87:13 88:19 89:17 92:4,15 98:20 102:17 104:16 107:16 108:13 219:16 233:4 239:19 240:10,17,21 241:3,4,13
shippers 380:19
shipping 78:11 86:12 93:6
ships 8:3,15 62:2 66:4 70:16,16 74:13 84:14 86:3 88:18 91:3,19 92:8,9,10,14 103:6,9 112:5 172:1,5 181:8 181:15 182:11 183:5 219:13 221:10 241:9 315:18 324:2 364:2
shoal 120:10 128:9 153:8
shoaler 222:20 229:19
shoalest 35:5 151:17
SHOALs 129:10,11 130:19
shoot 351:13
shore 63:20 102:16 154:12 250:13
shoreline 74:14 112:7 114:22 159:1
short 5:19 49:21 155:17 298:22
shortcoming 267:20
shortens 383:15
shorter 129:22 130:6 155:15,15
shortly 110:8 221:22
shout 335:10
show 16:8 19:6,18 20:15,21 22:14 26:11 34:13 48:9 101:6 124:8 131:3 142:20 158:7 173:12 329:3 348:10
showed 10:6 27:15 36:22 98:4 199:15 327:14 382:7
showing 37:17 38:13 49:3 63:19 66:10 132:8 142:15 243:13 319:7
shown 145:12 230:16
shows 12:10 80:4,4
shut 156:14
shy 375:12
side 13:19 30:20 74:15 80:5 83:15 88:19 102:16 106:12 108:11 171:2 176:18,22 201:13 238:5 304:2,3 316:3 335:9
sides 79:7
Siegel 15:22
sightings 65:12
Sigma 157:14 158:11
sign 344:9,10
signal 126:12 129:19 129:20 130:13 147:10 147:12 294:2
signed 223:22 353:2
significant 44:17,21 231:5 347:17
silo 104:5,6
siloed 256:22
silos 105:12 107:19 257:10
similar 45:14 121:14 131:5,7 132:6 157:4 174:13 251:6 255:11 268:21
simple 47:15 51:12 147:6 262:19 275:16 275:21
simply 289:21 297:8
simulations 90:2
simulator 20:17 46:10 46:16
simulators 20:19
Simultaneous 61:17 108:9 238:16 343:19 346:1 352:3,15
simultaneously 26:15 240:1 252:16
sin 43:11
sing 7:8
single 11:11 26:10 55:13 58:16 96:5 116:22 118:17 125:17 125:21 126:10 143:1 143:17 144:10 157:3 164:17 239:5 247:4 256:3 259:7,10,16 260:2 291:17 292:22
sir 215:5 231:12 338:9 343:16 383:6
sit 16:13 40:6 45:10 166:12 216:19 228:15 260:22 269:6 271:11 281:8
site 90:15
sits 219:3 267:18
sitting 4:10,10 70:5 135:2 144:7 183:18
situation 48:6,19,20 80:5 82:11 93:9
situational 49:10
situations 93:2
six 7:5 31:6 59:17 77:16 192:8 316:1
size 118:2 121:3 133:21 225:17 231:9 233:4
skeleton 241:16
sketch 219:21
skill 62:8
skin 380:8,13 381:10
skinny 346:3
skip 117:11
skipped 150:9
slack 138:14,15
slant 144:2
slap 26:6 53:16
sleep 338:21
slide 36:21 80:4 97:12 97:13 137:3 142:20 143:21 201:10 202:3 221:12
slides 200:2 239:12
slight 314:1
slightly 104:17 123:8 124:9
slip 29:5
slopes 143:6
slowly 113:4
slump 27:20
slumped 27:21
slurred 21:5
small 7:5 46:9 49:8 91:15 108:14 127:18 156:18 221:14 314:17 316:18 365:11
smaller 115:22,22 118:6 119:17 120:21 121:4 125:1 127:9 131:8 134:1 145:21
smallest 133:15 134:5
smart 20:13 31:11 56:14 89:5 358:13

smarter 73:22 154:6
smartest 74:4
Smith 2:7 4:8,9,11 29:11 190:4 213:20 244:8,21 246:4 291:11 300:12 316:3 326:2
smoother 73:2
snapshot 146:13 326:22
so-and-so's 339:7
soap 89:12
social 92:21
Society 372:4
software 23:10 225:1 226:22 227:8,14 228:3
sole 273:14
solely 273:3
solid 229:11 314:11
solution 70:2 279:20
solutions 90:9 176:10 218:13
solve 197:9 271:3 288:18
solved 270:20
somebody 53:8 164:18 194:18 207:15 219:20 260:16 263:3,7,8 290:20 325:15 332:10 352:19 361:17,19,19
Somebody's 298:3
somewhat 295:5
sonar 25:22 26:8,10,11 27:11 254:4
sonars 25:4 58:15 169:11
soon 45:1 155:20 181:16 347:20
SOPs 377:4
sorry 24:6,8 34:1 58:21 83:16 181:4 183:2 210:8 259:14 264:19 312:10 313:11 314:4 315:2 320:18 333:4 365:19 383:6
sort 9:16,17 68:19 71:19 72:17,19 73:9 74:9 75:6,7,11 79:13 79:14 83:17 84:14,19 85:1 86:1,2,14 87:11 88:12,15,17 89:13 90:18 92:13 95:8,17 96:7 99:15 106:14 111:3,5 153:18,20 170:14 172:12 184:20 187:9,17 211:20 222:22 223:8 226:11 250:21 260:4 265:3 282:12,19 322:22 327:4 338:19 363:18 367:2 369:7
sorts 9:14 19:19 185:21
sound 5:22 25:15 75:13 176:1 225:8 228:16 230:3 231:7 236:10 303:21
sounding 227:16,21 317:2,8
soundings 43:14 66:11 70:10 112:9 223:6 227:17 228:7 229:14 231:4 236:7 291:20 292:11 348:10
sounds 113:18 298:18 303:9 322:3
Soup 215:18
source 133:12 161:17 291:13 292:5 343:21 344:3
sources 90:18 245:16 275:11 304:16
soybean 221:3
soybeans 221:4
space 74:6 80:9 157:15 158:12 178:15 346:8
span 49:21
spatial 80:16 81:13
speak 249:6 252:21 277:3 328:20 329:14
speaker 2:21 5:15 247:15
speakers 13:2 328:20 331:1,2,5,12 367:14 375:16
speaking 61:17 108:9 238:16 279:13 283:6 328:1,2,6 330:10,16 343:19 346:1 352:3 352:15
spec 158:10
special 111:19 132:10 132:15 192:3,4 211:8 274:16
specialty 311:18 312:7 312:7 368:16
specific 73:17 74:20 81:1,21 87:4 114:10 155:3 176:4 184:14 184:18,19 186:6,21 187:12 188:12 203:1 207:21 256:14 262:16 278:18 279:1 281:14 285:17 289:15 319:10 348:20 354:1 355:20 360:9 369:13
specifically 72:14 169:10 172:12 204:4 272:21 281:9 285:7 289:8,11 353:7
specifications 208:4
specificity 269:3
specs 35:20 208:6
spectacular 20:19
spectral 119:12,19
sped 25:18
speed 91:3 241:12
speeds 131:3
spell 329:6 330:20
spend 79:17 199:3 240:12 287:5
spent 34:6 76:14 199:7
spill 44:13,14 200:5 296:3
spiral 26:3
Spirit 84:1
split 26:11 33:16 120:2 126:12 221:14 263:10
spoiled 141:6
spoke 13:20 95:6 333:21
sponsored 263:16
sponsoring 263:20
spot 234:15 307:12 374:14,20 375:8 383:13
spread 152:4
square 132:20 160:17
squeaky 305:20
staff 2:7 74:14 78:15 80:19 112:2 285:2 339:6,7 340:7 365:7 382:9,12
staffs 372:22
stage 166:6 340:17 345:4
stages 226:20
stain 32:21
stakeholder 258:2 270:9 291:3
stakeholders 240:3 248:21 249:13 250:2 268:1,8 271:2 304:7 324:15
stamp 57:10 225:16
stand 16:14 95:16 166:9
standard 48:8 55:12 68:16 69:19 99:11,17 109:9 118:5 224:22 248:10 253:9,21 254:1,3 261:18 274:16 277:21 280:14 280:20 287:1 344:4
standards 67:11 69:6 69:12 108:3,18 111:18 112:10 235:19 236:1 246:16,19 248:7 250:20 251:1 253:19 254:14,14,18 255:15 258:1,7,8 260:18 261:7,12 268:10 273:16 274:12 274:13 277:13,20 278:8 280:9,16 282:1 282:5 286:12 288:1 289:3,5,10 290:2,3,7 297:11 299:20 304:21 315:13,21
standing 115:9 166:10
standpoint 226:6 230:7 230:19
stands 209:14
start 16:5 35:8,14 40:18 44:20 51:10 57:4,8 67:22 86:7 96:22 108:1 112:4 115:15 115:15 128:18 134:11 137:9 146:21 147:9 158:9 163:8 179:17 218:17 226:3 227:9 234:19 257:4 259:17 314:7 330:19,20
started 5:7 17:13 40:16 43:18 54:19 69:3 70:11,12 117:15,19 118:21 119:5 166:18 168:11,13 170:16 187:21 194:16 215:22 220:11 244:6,11,17 264:3 288:19 318:4 330:21
starter 348:19
starting 23:22 42:16 47:8 69:15 103:9 127:5 159:15 161:9 162:11,16 224:10,11 244:19 253:12 295:14 305:10 341:12 354:2
state 37:8 46:2 47:4 52:16 54:3 57:14,15 58:9 87:9 100:21 140:11,14 156:14 219:2 252:19 253:5 254:7 261:3,5 322:10 322:12 324:1 326:18 350:1 365:12
State's 365:15
stated 326:2 337:21
statement 256:5 263:21 264:6 265:4 275:17 276:1 279:16 285:18

286:22 298:3 308:6 336:4 340:10 342:19 353:6
States 11:2 96:12 106:6 184:7 249:18 316:8
static 133:9
stats 221:2
status 57:11 150:22 371:12
statutory 273:7
stay 166:11 214:4 215:6 257:10 355:21 379:13 383:12
steaming 33:10 67:1
Stebbing 5:18
steel 82:15
steep 143:6 144:6
steered 62:6
step 179:7 225:12,19 228:9,11 237:19 266:6 318:2 322:4 341:10
steps 40:13 235:13
stereo 37:18 38:13
stewardship 340:9
stewing 46:9
stick 20:2
sticking 38:8
sticky 85:10 88:8
stimulated 323:18
stop 30:21 49:16 212:20 222:1
stops 222:15
store 91:17
storm 93:6,8 219:15
story 89:13 215:21 238:8 324:8 328:11 328:12
straight 177:8
straightforward 141:22
Straights 150:3
Strait 184:8
Straits 142:19
strange 69:16 262:6
strategery 194:19
strategic 74:17 105:15 106:12 251:10 282:20 283:11,20 284:9 308:13
strategically 339:5
strategize 304:19
strategy 75:7 77:14,15 93:11 270:9 272:1 326:5 337:12 365:8
stream 69:5
streams 69:4
stress 302:12 304:18
stretch 79:3
stretching 123:4
strictly 103:13
strikes 344:14
stripped 8:17
strong 125:6
stronger 124:17
strongest 143:15
strongly 202:18 383:9
struck 243:8 303:5
structure 39:11 294:10 295:2 315:11 367:8 370:13,19
structured 107:11
structures 79:7
struggle 168:4
struggling 262:17
stuck 71:2
student 19:10 45:16
students 29:14 36:4,6
studies 19:4 21:9,18 22:2 248:22 262:20 263:14 264:12 265:5
study 36:8 61:3,15 242:7 249:2 251:10 251:21 252:3,5,11 253:14,15,18 255:19 256:3,16 263:1 268:21 272:19 273:10 273:20 278:14 279:15 282:13,13,17 283:2 283:13,22 300:17 363:10,13
stuff 12:9 14:6 21:19 23:22 29:19 43:8 46:11 61:5,12 69:8 70:22 154:11 155:5 159:17 164:6 184:5 187:2 212:3 228:2 251:15 257:22 258:5 273:21 282:18 295:8 295:13,19 305:5,7 311:18 312:9 313:17 315:15 323:10 335:15 335:17 358:17,19 359:15 381:20 382:5
stun 26:6
stupid 183:1
subject 50:12 54:5 114:5 206:12
subjects 15:16 188:11 332:8 366:18
submarine 23:12 71:5 117:16
submarines 23:7
submissions 350:10
submit 266:20 301:12 341:16 342:16 353:16 354:1,11
submitted 272:1
substance 207:3 295:14
substantive 293:13,21 294:4
subway 37:4,6,10
success 203:9 204:7
successful 119:22 136:3,5,7 138:14 220:17
succinct 378:5
sudden 270:4
suggest 262:22 264:15 264:16 275:1 355:5
suggested 247:16 362:4 377:6
suggesting 257:1
suggestion 261:20 262:16 279:20 290:4 302:2 330:22 336:7
suggestions 249:15 287:21 331:12 378:20 378:21
suitable 48:17 135:16 135:17,18 137:18
Sullivan 40:17
summarize 5:12 346:9
summary 14:17 71:16 166:13,15 180:2,4 198:3 339:22 340:2
summer 179:14,16 240:5
summit 275:7
sun 174:2
sunshine 155:20
super 377:16
superimposed 47:5,6
supplemental 301:4
supply 96:8 215:13,16 217:1,19
supplying 99:3
support 78:15 87:4 97:1 172:17 182:4,12 185:4 209:2 235:7 236:7,17 242:4 279:5 306:17,22 307:2,19 317:20 320:11,20 335:7 358:2 363:21 366:17 369:16 372:15
supported 306:18
supporting 174:18 176:14 222:1 324:2
supports 288:21
supposed 114:9 193:1 214:17 288:15 332:5 358:7
surface 23:6 24:7,12 26:6,6 29:4 32:17,18 32:19 33:1 37:22 121:4 122:9,12,16,18 122:20 123:4,7,9,10 123:12,15,20,22 124:12,12,14,20 125:3,6 128:14 129:2 129:14 130:8,22 133:13 140:3 144:8 159:16 164:15
surfaces 136:17
surfers 261:16
surfing 58:1
surprised 42:7 331:22
surprising 28:5,7
surprisingly 361:11
surrounding 95:12,17
survey 2:3,8,14,19 13:19 42:19 57:13 66:12 83:7 85:15 111:10 115:19 116:5 116:10,22 117:6,8 119:9 135:15,19 136:3,8 138:9,14,14 138:17 140:16,20 141:15 153:17 155:15 155:15,17 173:7,20 174:20 176:17 178:18 178:20 179:10 221:13 231:3 246:19 259:6 274:15 276:4,15 280:13,18 290:7 326:5 343:22 344:1
survey's 290:6 292:4
surveyed 258:14 277:12 286:8 287:22 297:10 299:19
surveying 61:22 100:19 102:1 118:21 173:10 245:10 246:1,17 255:5 256:14 281:10 286:6 289:4 299:14 305:13
Surveyor 62:14
surveyors 372:5 380:15
surveys 2:13 11:14 37:2 50:10 54:2,6 85:15 111:11,21 142:4 152:20 178:19 191:7,11,20,22 192:11,12,15 208:4,8 208:22 209:2 218:8 228:22 230:12 275:12 287:4 288:15 291:12 291:16,17,21 292:2
Susan 1:20 6:13 60:1 64:10 244:1 284:1 285:16 302:18 342:6 348:18

suspect 155:7
suspected 32:4
suspicious 87:17,19 283:6
swallow 116:6,7
swallower 116:1
swath 116:4 118:11 119:3 122:6 131:6 139:16 267:19
swear 34:5
sweep 35:18
swift 141:21
switch 221:12
switched 134:4
synthesized 338:5
system 11:3 33:7 62:17 64:16 77:8,10,12 82:22 87:13 88:5,6,9 98:18 100:5 116:19 118:12 119:4,13,14 119:15,17,20 125:4 126:1,6,22 128:9 129:21,22 130:6,6,10 130:10,13 132:18 133:15,15 134:16,19 134:21 139:8 151:14 152:1 162:4 182:2,21 210:14 220:12 222:17 233:15 236:3 238:13 362:6,10
systems 68:12 76:22 77:1,5,6,8,9 81:12 109:13,15 118:1,4,13 120:9,11,14,16,19,22 121:6,19 122:19,22 125:1 128:7 131:16 132:16 133:14 134:20 149:11 151:4 158:12 159:10,21 169:18 171:7,15 172:1 179:4 181:8 210:6 224:17 254:16 362:11,13

T

table 94:3,4 271:12 292:20 302:4 366:9
tackle 213:22
tactical 283:9 312:4
tagged 26:14
tagging 25:11,12
tags 25:10,12,13
tail 376:1
taken 82:5 241:5 301:2 312:16
takes 62:12 93:15,16 109:10 199:8 228:2 235:14
talented 18:18
talk 14:4 16:15 28:14 54:21 64:12 72:1,4,11 77:14 102:6 109:19 113:9 114:1 121:9,10 131:15 132:21 146:4 146:6,6 163:8 170:11 178:6 180:16 191:15 209:8,9 214:7 216:9 216:11 217:2 218:19 234:15 239:2 243:10 267:17 285:1 295:19 304:7 305:22 320:19 322:20 323:9 332:11 336:13 346:10 355:1 357:11 358:9 365:4 365:22 368:8 375:18
talked 9:16 17:2,9 21:21 104:1 113:9 154:21 169:3 172:1,2 172:19 217:13 218:4 256:20 285:7 295:6 326:4 366:20 367:19 379:16 381:11
talking 19:20 64:13 97:6 99:7 111:9 116:7 128:10 150:9 171:13 174:22 176:9 183:6 192:5 209:6 215:20 216:17,18 218:11 234:13,14 243:8 255:5 259:17 270:5 279:16 280:22 283:3 290:21 295:7 297:8 298:11 311:16 314:17 316:15 346:6 361:1 366:6,7 380:17,18,19
talks 200:20 201:13 365:15
tangent 332:22
targeting 348:7
targets 31:20 175:9
task 51:16 256:6 263:21 264:6 265:12
tasks 8:18 315:8 349:3
tax 199:5
teach 65:11
team 44:2 45:14 239:15 240:2 241:17 246:10 247:8,19 248:7,15 255:9 262:14 264:9 264:20 293:1 299:15 318:8
teams 7:5 248:1
tech 3:15 218:19 379:9
technical 9:7 33:14 114:5,20 150:10,12 166:16 173:2 202:16 236:19 250:4,19 252:8 319:18 322:17 323:9,10 330:14 337:18 360:3 363:22
technically 277:20
techniques 27:18 68:1
technological 12:5 271:9
technologies 20:1 92:1 183:20 184:1,15 198:17 217:5 325:7 362:17
technology 3:3,4,10,13 12:16 13:13,13,17,22 14:7 15:9,16 17:6 28:21 46:2 63:8,16 64:1,5,14 66:8 68:21 71:16 86:5 93:13,15 97:6,20,22 101:3,6 105:6 106:1 110:14 113:2,7 114:3 116:5 126:7 147:3 154:19 157:1,3,5 167:10,15 167:16,18 168:14 174:4,14,16,18 175:2 180:10 184:20 185:20 186:4,22 187:21 189:15 193:2,21 197:15,16,22 198:9 199:18 201:6,14 210:10 212:2 221:21 267:12,22 304:15 305:8 306:5 312:9 315:17 318:1,12 319:6 320:15 321:1 344:22 363:18 367:3
technology/interesting 16:8
techy 194:17
teleconference 294:9
telecons 293:6
telepresence 173:13
tell 53:10 89:16 154:14 223:17 284:9,14 288:13 292:8 297:16 331:13,21 356:5 373:8 375:7
telling 56:19 89:10,11 279:10
tells 289:13
temperature 139:5,5
temporal 25:2,3
ten 116:8 133:7 161:1,8 163:12 192:6 195:22 205:9,10 220:5 231:19
tend 63:13
tends 35:7
tens 200:11
term 308:2
terminal 106:14,15 111:10
terminals 80:11,14 95:8
terminology 223:14
terms 22:3,11 29:22 31:19 36:20 41:4,12 41:13 44:17 47:17 49:17 92:19 167:19 206:21 207:21 255:3 272:17 329:21 333:14 374:13 375:8 380:9
terrain 135:22
terrestrial 157:2
terribly 333:13
territory 40:11 317:4
test 21:10 27:13 33:10 34:7,17,18 68:2,7,12 224:8,15 230:3
tested 68:13 109:11
testimony 198:7
testing 158:5 226:21
text 41:2
thank 6:16 8:10 11:5 13:4 16:14 21:5 34:1 35:22 37:13,13 72:11 96:20,21 113:15 165:21 188:18 213:10 213:12 239:7 291:9 292:14 315:15 317:6 317:21 319:8 323:11 324:2,11 338:10 342:6 343:16 362:2 372:14 374:12 382:6 383:19
thanks 13:9,11 59:22 71:11 72:9,10 109:20 115:3 165:18,20 199:22 205:11 271:20 320:8 366:12 378:14 382:19
theater 18:2
thematic 81:1
theme 13:7 72:22 181:7 182:22 302:10 322:22
themes 180:15 320:12 324:21
theoretically 225:16
theory 121:14
thermal 133:22
thesis 36:7
thingie 335:1,2
thinks 300:10
thins 142:7
third 4:4 188:15 252:14
THOMPSON 1:20 163:17,21 165:3 302:9 358:5 373:21

thorough 376:10
thoroughly 300:20
thought 9:5,8,10 15:5 16:1 31:11 37:15 43:17 65:16 72:6 148:11 149:22 178:2 186:5 206:10 207:19 211:21 212:14 228:4 251:7 257:18 260:15 272:20 273:19,22 308:8 323:13,17 326:11 334:10,19 343:6 348:2 360:5 361:13 377:8,11 378:3
thoughtful 293:3
thoughts 96:9 258:12 272:13 300:9,13 301:16 351:11
thousands 73:10
thread 169:19
three 10:13 12:17 14:18 33:6,6 136:21 149:2,3 156:10 188:1 190:8 219:10 232:10,10 244:22 245:2 247:1 278:13,20 291:1 292:21 298:5 301:11 304:10 309:7 336:2 340:2,21,22 342:7,15 342:16 343:13 362:10 377:5 381:6,17
thrilled 43:22
thrilling 325:8
throughput 73:21 95:3
throw 202:19 297:6 364:22 366:8 377:8
thrown 283:14
Thursday 1:8 310:21 311:2
tickle 103:9
tidal 119:6,7 141:12,22 161:19 333:17
tide 44:11 45:2,3,3,5 48:14 86:17 138:15 138:15 141:17 280:15 335:6
tides 9:1 119:7 138:12 138:18
tie 9:19 36:15 104:2 182:20
tied 9:13 50:20
tier 242:11
ties 111:1
Tiger 240:2
tight 35:8
tighter 191:17
TIGWG 69:16
tile 236:22 237:1
till 207:20
Tim 4:19
timeframe 341:17 361:16
timeline 159:4
timely 262:21 366:7
timeout 314:6
times 61:5 85:20 112:1 126:11 136:21 137:5 149:2 154:5 156:8 191:8 194:3 198:6 332:5
timing 165:9,15 347:12
tiny 32:4,4 164:15
title 339:3
titled 245:9,12
today 4:17 5:3 10:17 59:1 103:7 109:18 121:10 217:17 238:9 292:18 306:5 310:11 326:13 327:1 359:14 367:11 369:7 377:4
told 107:19 237:4 331:18
Tom 38:13 39:14
tomorrow 168:8 180:21 181:2,4
tone 344:13,18
tonight 30:18
tool 10:13 44:13,18 45:9 46:11 49:7 59:19 60:13 113:19 128:4 135:16,17 137:18 139:3 153:21 156:17
tools 16:17 20:12 24:20 114:2 172:8,17
top 30:1,2 67:10 68:18 82:1 97:11 129:16 242:11,16 329:12 336:2 361:5,20
topic 9:22 193:7 258:4 272:3 273:3 274:4 320:22 323:3 326:13 338:14 361:10,12 363:1 369:7 372:1 373:6
topical 328:19
topics 10:2 11:7 12:22 13:8 17:3 18:6 96:17 205:5 245:4 329:13 357:10,18 358:8 359:4 360:22 365:6
topo 118:16 121:17 132:21 134:12,19 142:22 157:12 165:2 179:3
topo- 143:6
topobathy 160:13 162:7
topographic 160:10
tops 250:11 251:3
torn 367:2
total 56:4,10 90:13 205:8 244:22 355:3
totally 22:19 48:6 54:16 81:19 165:4
touch 185:10
tour 357:13 370:22
tourism 340:10
TPU 162:19 191:15 192:1
track 26:1 40:7 69:10 70:18 92:14 194:8 207:1
tracker 35:7
tracking 35:4 61:4,5
trade 16:18
traditional 24:2 26:10 120:4
Traditionally 24:16
traffic 93:7 106:16 142:6 303:21
train 73:9
training 47:10,14 65:22 66:1,6 204:1,1
transcends 297:1
transcript 339:16
transfer 3:13 167:15,16 177:10 197:22 201:5 201:14 218:20 320:14 348:12 363:18 379:9
transferred 198:18
transferring 109:13
transformation 161:18
transformations 133:12
transit 107:16
transition 101:11 179:20 182:8 205:9
transitioned 206:15
transitions 197:15
translate 141:11
transmitted 23:12
transparency 318:19
transport 36:15
transportation 78:13 95:10,11 96:4 340:8
traps 26:5
traveling 124:3 147:17
travels 124:1 383:17
Travis 2:17 15:21 180:2
treating 292:10
trees 144:5
Trelleborg 224:5
tremendous 51:10 70:8 198:9
tremendously 55:19
trend 118:1 121:21 125:10
trends 96:3
trial 27:13
triangle 83:16
Tribe 333:16
tricks 22:14
tricky 347:6
tried 15:13 33:2 148:7 167:11 168:3 201:11 202:12
trip 27:13
trivial 75:14,15 81:6
trouble 245:13 265:7
truckers 78:11
trucking 78:10
trucks 73:10
true 10:15 31:17 34:12 38:13 39:1 40:14 56:1 56:9 58:18 149:13 155:12 238:11 251:19 319:7 381:10
truly 71:6 150:6 368:21 382:4
truth 55:5 56:6,20,22 77:2
truthing 164:20
try 17:7 19:2,5,12 29:20 68:8 69:6 75:7 114:4 136:9 138:8,17 148:3 162:18,20 164:19 166:14 199:1 214:12 223:4 224:14 233:21 248:11,12 257:2 297:5 299:1 346:7 378:2
trying 11:14 15:8 18:12 19:7 21:12 29:9 34:14 38:8 41:7 46:1 67:17 68:20 69:18 74:16,17 76:5 85:1 86:19 110:4 115:19 131:2 137:17 155:18 160:14 166:18 171:20 183:19 184:2 188:16 197:1 200:5 205:8 207:1 222:18 225:7,18 234:4 235:6 239:19 260:1,8 274:10 284:3 285:19 288:22 292:8 320:5 327:4 360:17,18 368:2 370:3 376:2
tsunamis 7:10
Tuesday 18:15 43:22 255:19 309:2 310:19 311:2
tuna 53:11

tuning 95:1
tunnels 79:5
turbidity 136:14
turn 41:8 134:18 215:5 218:18 238:10 240:12 357:4,6
turned 33:9,9 34:19,20 55:22 187:10 361:11
turning 37:8 113:4 231:2
turns 26:15,18 32:20 198:16 273:8
Twelve 65:3
twice 120:6 127:22 135:8 153:7 171:19
two 3:2 4:18 6:14 12:17 26:14 30:15 61:21 69:4,14 92:14 94:17 109:1 120:3,16 121:9 128:15,17,20 136:21 141:19 151:9 152:17 160:8 190:8,11 210:10 211:18 219:10 232:10,10 234:21 243:18 244:5,21 245:4,5 246:7 247:6 247:22 248:5 256:7 263:16 269:11 290:11 290:12,15 292:19,20 294:20 299:8,13 315:4 317:22 321:14 336:2 340:2,21 344:1 346:8 347:14 349:11 357:2,9,14 365:13 371:22 373:9 379:12
two- 333:8
two-head 134:19
two-page 202:13
tying 9:17 86:20
type 53:3 113:11 147:1
types 7:22 13:8 69:18 70:9 92:22 198:19 224:9 294:12 319:13
typical 82:2 90:10 202:13 222:6
typically 77:9 103:12 118:13 121:16 124:13 124:13,20 153:4 157:22 158:1 159:10 161:16 191:16 192:7

U

U.S 1:1 134:3 141:7 160:6 184:9
ubiquitous 78:7
UKHO 35:16
ultimately 193:8 222:18 224:20 226:2 234:3,8
ultra 219:16
uncertainty 21:22 94:12 112:12 132:5,9 132:12 133:1,8 162:10 241:6
uncharted 117:4 321:4 321:6
unclear 241:10
unconstrained 67:21 69:11
uncover 93:21
underestimating 55:19
underground 79:1,6
underkeel 45:6 233:12
underlap 190:4
underlies 174:5
underlying 81:3 174:17 182:3 237:22 333:19
underneath 63:13 115:21 132:19 143:20 144:9 237:10 362:7
underpinning 13:14 14:2
underscore 344:19,21
understand 10:4 14:14 19:18 43:3 49:10 78:17 91:22 92:1 94:12 97:21 163:6 166:19 168:1 186:7 195:4 225:19 243:5 260:12 277:7 298:6 313:22 316:13 326:21 331:15 341:13
understanding 180:6 274:19 323:2 353:21
understandings 259:2
understood 176:3 185:19 260:7 340:12
underwater 163:21
underway 242:1,4 252:13
undo 266:2
unemployed 12:20
unfortunately 49:21
unfunded 241:15
UNH 204:13 205:18 239:16 370:12
unheard 355:15
Union 96:3 219:2
uniquely 253:17 276:8
unit 68:2 133:22 134:22 221:19 222:2 224:2
United 11:2 96:12 106:6 184:6 249:18 316:8
units 67:20
unity 258:2
universities 65:10 253:4
university 17:13 177:1 203:18 229:4 254:10
unmanned 4:21 159:21
unpredictable 91:8
unsuccessful 135:19
unused 74:6
up-to-date 42:4
upcoming 363:4,9
updatable 41:19
update 15:15 42:18 179:18,22 190:3 209:13 239:12 363:9
updated 50:16 98:5 99:13 245:19 274:21 348:6
updates 85:19 91:12 348:8
updating 85:18 100:16
urban 73:14 78:12
urge 249:8
usable 145:4 259:11
USACE 291:12
usage 304:22
USCS 72:18
use 12:7,13 36:19 37:15 38:6 44:3 51:6 53:9 55:13 56:9 59:10 65:9 84:10,18 86:4 90:12 92:10,12 96:11,14 98:12 99:14 108:7,11 108:13 112:1 114:2 114:17 115:17 117:19 121:21 123:11 125:11 125:12 126:2 127:18 135:17 137:21 138:4 139:6 146:22 147:21 148:3 160:17 165:5 179:7 183:19 185:12 191:8,21 192:1 207:20 209:1,1 222:3 259:10 260:1 261:17 268:3 271:4 281:2 289:12 292:4 308:2 320:7 337:2 356:1 362:1 368:8 375:17
useful 23:16,17 123:17 137:17 138:11 142:2 149:21 154:3 159:16 172:15 177:11 283:15 318:18 334:11,12 338:3
user 136:22 171:5 234:4 237:7
users 8:21 64:8 67:15 70:7,21 91:1,22,22 171:3,7 303:8
uses 42:17 73:4 126:7 253:22
USGS 90:19 250:10
usually 131:12 137:4 191:15 249:17 334:21 346:22
utility 59:2
utilize 76:10 375:8
utilized 200:7
utilizing 87:3

V

valid 145:5 207:10 212:17
validate 153:22 191:7
valuable 178:12 295:9 320:7 323:17 346:9
value 7:4 10:16 38:22 93:18 199:12 223:19 322:16 324:15,16
value-added 146:5
values 237:2
VAN 2:19
varies 164:2
variety 12:22 92:20
various 89:19 90:18 99:19 164:8 216:8 220:14 224:9 250:2 250:17 254:11 267:22 304:16
VDatum 9:18 319:19 321:11 359:10 366:17
vector 148:13,13
vectors 21:14 24:12
vegetation 143:20 144:1 149:15
vehemently 310:13
vehicle 343:18 357:19
vehicles 325:8 332:1 357:12 359:6 371:6
velocity 91:3
verify 163:19,22
version 59:5 164:16 202:9
versions 177:6
versus 60:13 61:6 130:22 214:14 223:14 330:4 360:1,2
vertical 26:1,10 132:11
vessel 12:9 46:21,21 48:21 49:5,8,8 55:18 56:2 99:9 115:19,21 116:12 117:7,10 155:16 164:15 179:4 238:20 239:4 314:16 314:17 316:18,18
vessels 29:16,19 70:7 83:7 98:6,9,11 99:2 116:10 117:4 159:16 179:8 221:6 275:20

286:7 364:11
vetting 292:2
vibrant 216:11
video 32:5,7 48:12
view 58:10 75:12 81:14 81:15,19 82:2,8,13,17 83:3 101:5 126:17 257:13 311:13 312:11 367:4,9
viewpoint 336:21
views 72:5 74:21 75:3 82:1 92:17 272:4
vigorous 213:8
villages 78:13
vintages 229:1
violate 230:20
violated 60:22
violates 227:21 229:15
violent 236:4
viral 58:9
virtual 20:17 46:10 47:6
virtually 173:5
visibility 23:14 358:1
visible 23:9 82:19
vision 205:11 251:14 251:17 305:13 378:5
visioning 308:13
visit 92:16
visited 5:20
visiting 86:3
visitors 78:11
visits 86:12
visual 65:12 337:13
visualization 3:5 15:2 16:12 17:9 18:9,19 21:8 22:13 24:17 27:7 27:17 44:3 51:21 79:10 337:7
visualizations 78:20 86:10
visualized 41:9
visually 82:11
vital 216:11 316:19
voice 112:18
voices 110:2
volume 90:1 91:20 124:5,16
volumes 90:5 91:10,13
volumetric 123:8
voluminous 90:11 252:5
voluntary 59:7
volunteer 343:9,14 352:13,16
volunteered 190:2 354:1
vote 353:11 354:16 372:7 373:15 378:11
381:20 382:1
voting 336:10
VTS 10:6 303:18

W

W 1:15
wade 164:12 276:22
wait 301:5
waiting 44:8 261:1
walk 381:5
walked 310:10
wall 66:22 76:16 81:22 82:8,9,13,15 83:1 88:8
walls 76:15 80:11
wanted 13:4 29:7 43:2 114:1 142:15 146:4 147:4 166:21 167:3 167:20 185:16,22 188:18 204:22 211:16 213:7 243:22 278:12 307:9 326:17 341:21 342:22 363:14
wanting 375:8
wants 64:19 135:18 178:22 210:20 217:3
Ware 21:8
warn 196:4
warning 353:1
washing 89:11,14
Washington 1:12 4:6,9 321:3 322:10,12 365:12
wasn't 28:5 108:7 151:5 187:10 193:1 237:4 296:14 314:5 346:6
waste 378:12,14
watch 37:6 60:20
waters 154:20 195:6 321:4,7
waterway 50:10 73:16 79:7
waterways 5:17 79:3 79:14 290:18
wave 23:6,14 44:17,21 58:6 128:8,13,15,18 129:11,16 130:9,17 130:20 140:17 143:12 143:13 145:6
waves 44:1 58:8 144:16 145:3
way 8:17 10:7 12:7 19:6 19:8 20:3,4 21:13 38:6 39:19 41:9,15 47:12,13 55:21 62:12 65:11 66:17 67:4,4 68:15 70:20 71:3 74:7 83:19 95:13 99:8
107:1,10 109:12 122:12,19 124:9 128:22 132:4 136:22 149:1,7 152:3 163:2,3 167:21 175:2 179:10 181:20,20 185:8 188:4 204:11 218:5 248:19 254:19 256:16 263:6 275:4 280:16 284:11 292:6 295:3 300:3,3 303:1 308:12 308:13 311:13 314:9 315:19,20 316:4,17 321:18 325:1 349:13 370:1 375:10 376:10 382:2
ways 12:12 14:12 20:8 21:20 36:13 41:5 78:22 84:10 93:22 102:13 105:22 137:1 137:19 218:10 248:2 268:2,2 269:11 279:11 287:13 305:12 308:7 355:14
weaker 124:20 125:2
weather 22:7 23:2 86:18 93:6 94:15 135:21
web 42:18 209:4
website 42:19 90:15 150:20 177:21 178:3 247:5 318:21 319:5
websites 201:16,17
wedge 206:19
Wednesdays 311:4
weeds 180:11 194:18
week 28:1 37:3 85:11 202:14 262:20 270:2 346:20,21 349:11
weekday 92:6
weekly 42:18 287:4
weeks 222:14 300:2 326:10 340:20
weigh 82:21
weight 118:2 135:7
welcome 4:4 196:4,7
went 15:14 24:10 29:20 58:9 62:14 112:21 168:22 171:22 174:15 175:20 185:18 213:3 224:3,4,4 277:14 299:4 361:20 383:22
weren't 151:10,16 178:13
west 73:13 80:8 173:11 304:2
western 76:3 83:15 173:20
Weston 170:6
wet 335:9
whales 25:18 26:15
whatnot 295:2
wheat 221:3
wheel 305:20
wheelhouse 188:17
white 28:20,22 137:7 140:12 144:1,12,20 144:21,22 205:6,6 207:12 334:10,13 381:5
whiz 212:2
whoever's 11:1 288:15
wide 22:6 27:9 73:13 75:12 79:20
wider 118:11 119:3 126:17
widget 39:21
widgets 39:15,18
width 34:8 139:16
widths 116:4 118:11 119:3 131:6
Wiley 228:18
William 1:12,14
willing 207:15,16
win 243:11,12 299:12
wind 21:15,16 22:4 23:14 24:2,6 139:13 139:19
window 42:7 61:6,13 67:3 155:22
windows 48:16
winter 219:14
wire 35:18
wish 371:7
wonder 114:7 344:17 371:11
wonderful 39:14 43:13
wondering 26:17 99:2 309:12
wonk 278:7
wonky 223:14 237:3
word 43:12,15 69:22 70:20 199:3 220:18 353:12 373:12 379:12
wording 275:2 346:2
words 289:12 293:12 314:13 318:12 344:19 345:2,7 346:16
work 6:10 14:13 18:12 23:4 26:19 40:17 42:16 54:7 57:14 69:6 72:12 74:15 88:1 90:16 96:8 121:16 136:1 141:13 152:2 152:18 154:8,11,22 155:11 156:5 173:2

175:22 191:19 213:16 213:18 215:8 259:6 262:4 266:2 279:16 290:2 299:8 302:5 303:1,1,3 309:12 311:20 312:2 313:16 314:12 316:2,8,22 319:2 326:21 346:19 355:14 364:1 365:7 368:21 375:2 376:4 376:12 378:21 379:5 380:3 381:4 382:15
worked 26:17 54:11 67:13 72:17 87:8 96:13 156:19 240:3 253:16 279:2
working 3:3,4,10,15,16 12:16 15:3 16:14 17:6 21:14 30:14 42:2 44:2 54:13 69:17,17 71:17 72:13 78:3 86:7,11,22 88:10 101:7 110:14 113:3 114:3 139:1,2 142:5 150:19 162:6 166:16 167:19 168:14 171:20 172:7,21 173:2 177:3 183:18 183:22 185:20 186:5 188:6,6 189:15 193:2 193:15,20,21 195:17 195:21 196:11,21 197:10 226:19 230:1 237:20 241:16,18 288:19 295:7 296:20 296:22 300:7 308:22 311:11,14,22 312:5 312:16 318:1,3,6,13 321:6 331:11 337:18 338:1,1,2 349:8,20,22 350:2,4,17 356:1,3,13 368:8
workings 98:7
works 45:1 68:4 173:1 313:10 362:16
workshop 362:17,18
world 8:7 49:12 60:14 68:3 71:7 73:7 74:2 83:14 84:2 89:6 132:21 159:12 181:16 217:3,15 234:10 303:9 365:2 366:4 376:9
worldwide 36:10
worried 30:18 61:12 256:6
worry 62:18
worse 158:8,9
worth 33:4 299:8
worthwhile 9:11 15:5 72:6 369:14
worthy 261:13,14,15 283:21
wouldn't 47:12,13 84:4 187:15 282:13
wound 254:15
wow 159:5 334:4 344:4
wrap 299:7 332:16
wrap- 20:14
wrap-ups 357:3
wrecks 35:11 54:4
write 23:17,18 205:5 207:15 225:1 272:15 284:11 298:20 334:2 334:3 352:10
writes 21:18 39:21
writing 50:1 253:12 377:7
written 373:22 378:8
wrong 89:16 102:8 115:9 137:4 317:17
wrote 88:7 344:19

X

X 183:13
X- 366:13

Y

Y 183:13
yea 260:21
year 60:17 62:5 64:13 65:11 74:18 85:21 133:21 166:17,17 179:13 219:10 230:4 291:1 327:12 362:16 379:12
yearly 82:6
years 16:18 18:11 24:18 40:12 62:19,21 65:3,5 67:9 72:14 73:21 80:18 87:2 91:18 95:2 111:8 113:16 114:22 117:18 119:8 138:8 149:3 150:19 152:17 157:8 162:22 164:7 211:18 216:16 217:16,17 219:8 246:22 247:1 254:9 260:22 284:4 289:3,18 290:5,10 291:1,1 300:8 340:13
yell 112:19
yelled 56:5
yellow 225:9
yesterday 5:9,10 6:5,7 79:12 90:3 108:12 109:21 208:5 221:3 231:17 247:16 257:21 274:22 303:18
yesterday's 5:13 6:17
yield 302:7
yielded 221:10
York 105:20 364:7

Z

Z 183:14
zero 116:8 128:11
zone 45:7 52:4,11 103:14 112:1 140:17 144:20 145:6 304:2
zones 36:16 261:16 303:20
zoom 234:5,7 236:18

0

1

1,000 21:3 46:12,13 78:3 91:19 219:16,22
1,200 158:5
1,400 27:19
1.2 130:18
1.7 208:6
1:12,000 236:13
1:140,000 233:2
1:15,000 232:20
1:25,000 233:1
1:30 195:20 196:3 213:1
1:35 213:4
1:40 236:14
1:5,000 236:13
1:80 236:13
10 52:5,8
10-year 337:14
10,000 126:11
10.8 220:3
10:15 110:13
10:17 112:21
10:30 110:12 112:17
10:34 112:22
100 51:11 238:17 240:18
100,000 46:12
1000 20:20
101 318:20 330:20 359:11 372:15 383:8 383:10
11 33:17 220:3 234:19 234:20
11:45 110:15
1101 1:12
113 3:9
11th 245:20
12 34:10,21 65:5 67:1
12:00 195:20
12:03 213:3
125 131:12
13 3:3
15 52:5,8 65:5 73:21 74:18 91:18 95:1 110:15 116:9,13 117:18 151:22 195:13 298:22 375:17,18 383:11
16 3:6 90:20
167 3:10
18 133:4
180 20:14
189 3:12
198 3:13
1980 62:15
1994 118:21 119:5 247:17 272:19
1a 152:20,22 277:22 286:9,19 287:16 289:13 297:11 299:20 317:9 336:5
1b 152:20
1st 341:5,7

2

2 95:14 221:8,9
2-1/2 367:5
2,000 33:7 73:9
2:00 309:2
2:30 338:21
20 1:9 79:3 95:1 173:5 231:20
200 64:13 65:11 118:22 153:5,10 217:16,16 217:17
2000s 254:8
2005 65:2
2012 119:13 219:5
2013 219:6
2014 221:17
2017 1:9
2018 377:22
202 3:15
2022 358:8
2030 320:19 366:13
21 62:5
213 3:16
21st 3:7
233 3:18
24 105:22 215:11 231:2
25 61:22 80:18 129:11 148:21 166:1 217:16 217:17
250 131:12
29 130:18

3

3- 40:21 71:6
3-D 23:7 24:21 25:1 39:1 48:20 59:16 62:2 62:3 107:4 249:22 250:7,8,15,17 251:6 251:17 260:20
3-DEP 250:16 251:7 252:3
3-dimension 37:16,17
3-dimensional 39:10
3-dimensions 40:6
3,000 73:8
3:00 299:4
3:15 299:2
3:19 299:5
30 16:18 33:15 34:15 38:3 52:3 58:4 67:9 107:12 231:21 347:3 375:17 383:4
30-year 344:9
300 33:18,19
360 48:12 82:5 92:17
379 3:19
383 3:21

4

4-dimensional 36:14 71:7
4:42 383:22
40 58:4 73:13
40,000 221:7
400 158:2
48-foot 46:21
490 138:3
4D 25:1 59:16
4th 1:12

5

5 3:2
50 133:5 221:7 231:21 232:5,8 240:17
50,000 263:11
532 138:4
550 131:11
57 47:19
5th 3:7

6

60 37:11 46:15
65 220:8,19
66 220:19
69 219:13 220:5

7

70 355:2
70's 117:15
72 3:7
76 219:12

8

8 296:15
8:00 309:3
8:30 1:12
8:31 4:2
80 240:9 241:4 296:16 355:3
80-85 18:2
800 20:20 21:3
800,000 21:2
820-G 134:3,5
880 134:8
880-G's 134:4

9

94 249:1 251:21 268:22 282:13
95 161:5,8 163:12

C E R T I F I C A T E

This is to certify that the foregoing transcript

In the matter of: Hydropgraphic Services Review Panel

Before: US DOC/NOAA

Date: 04-20-17

Place: Seattle, WA

was duly recorded and accurately transcribed under my direction; further, that said transcript is a true and accurate record of the proceedings.

Court Reporter