NOAA Technical Memorandum OAR OSS-001

Creating a baseline for future evaluation of progress in achieving the *NOAA Research and Development Vision Areas: 2020-2026*

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National Oceanic and Atmospheric Administration
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Executive Summary

In order to provide a point of comparison for future evaluations of progress made toward NOAA's strategic R&D vision, we performed an analysis of projects in the NOAA Research and Development Database (NRDD) related to the priority areas in the *NOAA Research and Development Vision Areas: 2020-2026*. We found the NRDD to be a useful tool for capturing a snapshot of NOAA's scientific portfolio related to priority topic areas, types of partnerships, project connections and distributions across priority R&D areas, and project readiness levels. We discuss the potential of logic models as an evaluation framework for the NOAA R&D enterprise, the role of the NRDD data within that framework, and additional steps NOAA could take to more holistically connect NOAA R&D to societal outcomes.

Introduction

Research and development (R&D) at the National Oceanic and Atmospheric Administration (NOAA) provide the foundation for observing and understanding the Earth's environmental systems in support of NOAA's mission to understand and predict changes in climate, weather, oceans, and coasts; to share that knowledge and information with others; and to conserve and manage coastal and marine ecosystems and resources.

Strategic planning for the NOAA R&D enterprise provides the basis for monitoring, evaluation, and reporting, and creates alignment with broader strategic plans (e.g., Department of Commerce strategic plans), statutory requirements, and other relevant documents (NOAA, 2018). The *NOAA R&D Vision Areas: 2020-2026* (*Vision (2020-2026)*) sets NOAA's priority research areas for the next seven years (NOAA, 2020). It is the fourth document of its kind for NOAA, with the preceding NOAA R&D Plans spanning 2005-2009, 2008-2012, and 2013-2017. The 2020-2026 document is organized into three Vision Areas: (1) reducing the societal impacts of hazardous weather and other environmental phenomena; (2) sustainable use and stewardship of ocean and coastal resources; (3) a robust and effective research, development, and transition enterprise. The Vision Areas are further broken down into Key Questions and objectives.

NOAA conducts and funds R&D to address specific aims or uses that transition into operations, applications, commercialization, and other uses (R2X) to inform decisions that enhance the lives of the American people. The NOAA Administrative Order 216-105B: Policy and Research and Development Transitions (NOAA, 2016) and associated Handbook (NOAA, 2017) outline the

system of readiness levels that support assessments of the maturity of R&D projects from research to deployment and routine use (Figure 1).

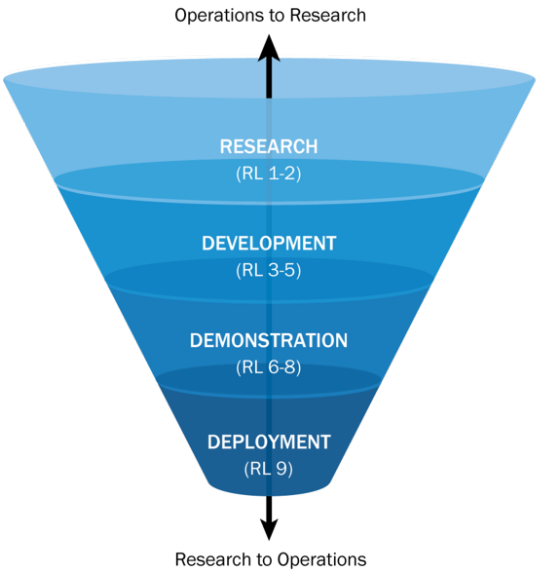


Figure 1. The transition funnel. While this funnel focuses on the interplay between operations and research, research is also transitioned to applications, commercialization, and other uses.

Evaluation of progress toward meeting the goals and objectives outlined in the *Vision* is key to assessing the effectiveness of the NOAA R&D enterprise. The *Vision (2020-2026)* states that it will be periodically evaluated according to the guidance in the procedural handbook of NOAA Administrative Order 216-115A: Research and Development in NOAA (NOAA, 2018), and existing mechanisms will be used to track progress. Existing data sources for tracking NOAA R&D plans, projects, publications, and transitions include annual operating plans (AOPs), the NOAA Institutional Repository for NOAA publications, and the NOAA Research and Development Database (NRDD). These data sources capture how NOAA R&D address requirements, such as legislation, and priorities, such as the objectives in the *Vision (2020-2026)*, to meet the nation's needs. Performance measures and metrics are used to assess whether targets are being met. Multiple metrics are needed to link across the NOAA R&D value chain—input to output to outcome—and across project readiness levels (Newcomb *et al.*, 2019). Such metrics include the Government Performance and Results Act (GPRA) performance measures, transition metrics, and bibliometrics. Scientific accomplishments are highlighted in the annual NOAA Science Report.

Taken together, these data can be used to build a logic model (Figure 2) for NOAA R&D that links planning (e.g., *Vision (2020-2026)*), user needs/requirements, scientific activities, and

societal outcomes. The logic model can be used as a tool to identify both successes and gaps in the chain of activities from research to outcomes.

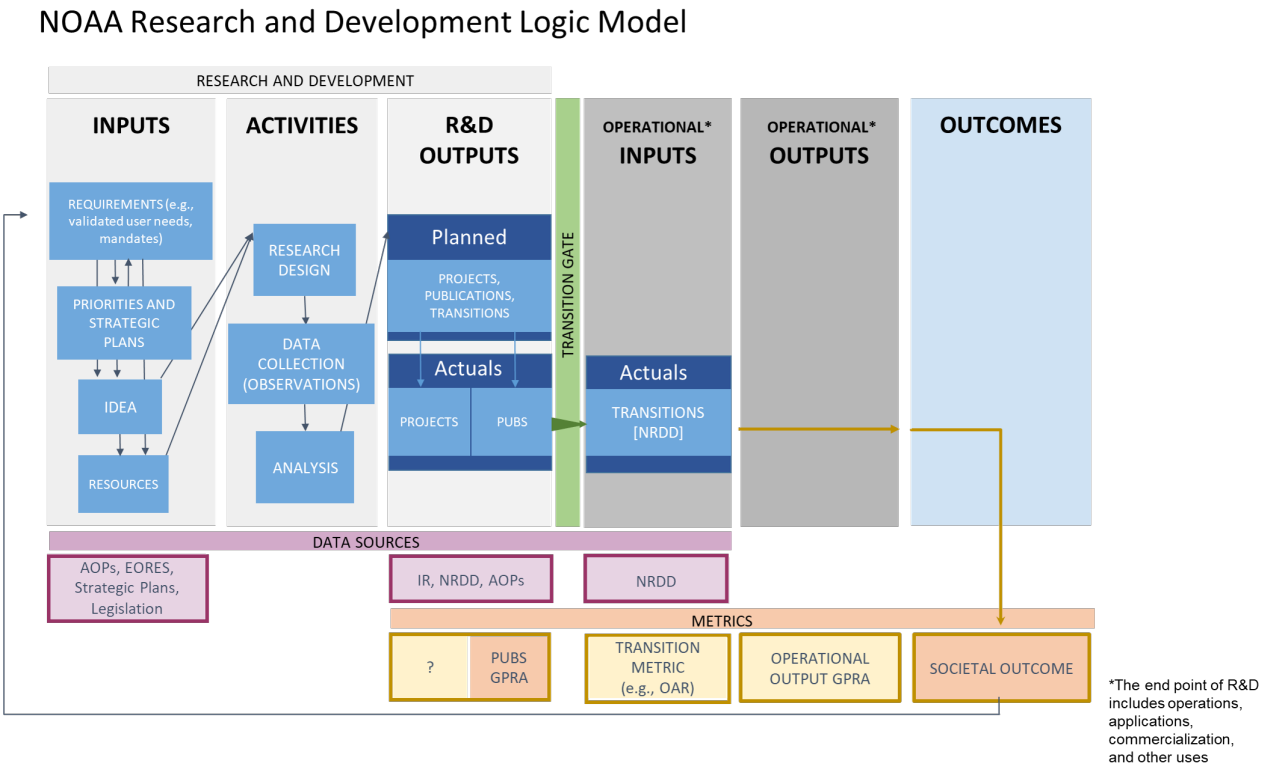


Figure 2. This base logic model for NOAA science outlines the relationships between user needs/requirements, R&D, operational inputs and outputs, and societal outcomes. Metrics can be used to track progress. This model can be personalized to fit a variety of societal outcomes.

As shown in the logic model, NOAA R&D are driven by societal needs. Desired societal outcomes inform legislative mandates and other requirements (e.g., validated user needs) for NOAA products and services. Requirements, priorities, ideas, and resources serve as inputs for R&D activities. Partnerships are key resources for NOAA R&D that can also generate R&D project ideas. The R&D activities follow the scientific method of forming and testing hypotheses, and lead to R&D outputs such as projects, publications, and transitions. These R&D outputs are used directly or transitioned into operational space, where they can be further refined into other outputs (e.g., forecast distribution systems) that impact outcomes (e.g., fewer lives lost due to hazardous weather events).

The logic model approach outlines the linkages of multiple projects and processes that contribute to a particular societal outcome to be achieved. In addition, logic models can highlight where more resources are needed to strengthen links and fill gaps between activities.

Logic models provide a useful tool for evaluating the effectiveness of NOAA's R&D enterprise in achieving R&D objectives over the period of the *Vision (2020-2026)*. However, to fully understand future progress, it is important to know what is being done and has already been done.

To establish this baseline we utilized the record of NOAA's science in the NOAA R&D Database (NRDD), an internal repository for project management data (Appendix 2) for R&D conducted and/or funded by The NRDD is one data source for populating the logic models. When placed in the logic model, the NRDD data fields provide traceability, from planned and actual research to development outputs to resulting operational components and anticipated outcomes.

The NRDD was established in 2017; therefore, it was not included in the evaluation of past NOAA Research and Development Plans (i.e., 2005-2009, 2008-2012, and 2013-2017). Given the lack of an existing baseline, in conjunction with the wealth of information available in the database to assess the state of the NOAA R&D enterprise, the goal of this analysis was to use the NRDD to create such a baseline that will inform future evaluation of progress-to-plan for the *NOAA R&D Vision Areas: 2020-2026*.

Methodology

The NOAA Research and Development Database was queried using search terms from the *Vision (2020-2026)* (Table 1). Search terms were identified by searching the objectives and Key Questions for descriptive words or phrases. The search terms were truncated (e.g., restor) to enable different forms of the word to be searched simultaneously (e.g., restore, restoration, restored, restores).

All approved projects (projects approved by an organizational manager with fiscal and managerial oversight) were queried from October 27-November 7, 2019 in the NRDD regardless of project date in order to provide a more robust baseline of NOAA R&D. Searching across multiple years, in this case from the beginning of data entry (fiscal year 2017 for most projects but with some office entries from 2014) through fiscal year 2019 planned project information, captures the ongoing nature of science and reduces the effect of imbalanced high or low Line Office (LO) submissions for a given year.

The search results included fields for project title, NRDD identification (ID) number, current readiness level (RL), Line Office, office, project benefit, project outcome, R2X type, planned start date, planned end date, and NOAA point of contact email.

Table 1. List of NRDD search terms related to the Key Questions in the NOAA R&D Vision Areas: 2020-2026 (as queried in October 2019). Appendix 1 contains a link to the manually reviewed data resulting from this query.

NOAA *Vision (2020-2026)* Key Question	**Search Terms**	**Number of Confirmed Records**
1.1. How can forecasts and warnings for hazardous weather and other environmental phenomena be improved?	• Forecast • Warning • Tsunami • Convective • Subseasonal	396
1.2. What is the state of the global climate and how are changes affecting local weather, including extremes, environmental hazards, and water quality and availability?	• Climate variab • Climate model • Cryosphere • Atmospheric chemistry • Atmospheric composition • Radiative forc • Water quality • Water availab • Extreme climat • Disease • Sea ice extent	144
1.3. How can the utility of space weather products and services be enhanced?	• Space weather • Space commerce • Solar flare • Ionosphere	18
1.4. How can NOAA enhance communications, products, and services to enable informed decision-making?	• Decision • Lead time • Risk communication • Business impact • Survivor • Risk threshold • IDSS • Also divided from 3.4	118
2.1. How can knowledge, tools, and technologies be leveraged to better understand, protect, and restore ecosystems?	• Protect • Restor • Marine ecosystem • Habitat map • Pollut • Traditional knowledge • Ecological knowledge • Change AND ocean	343
2.2. How can healthy and diverse ecosystems be sustained while meeting the needs of indigenous,	• Fish • Stock assessment • Seafood monitor • Bycatch	479

NOAA *Vision (2020-2026)* Key Question	Search Terms	Number of Confirmed Records
recreational, and commercial fishing communities?		
2.3. How can the growth of sustainable aquaculture in the United States be accelerated?	• Aquaculture	161
2.4. How can the conservation of coastal and marine resources, habitats, and amenities be balanced with growth in tourism and recreation?	• Tour • Recreat • Adaptation • Harmful alg • Ocean acidification	387
2.5. How efficiencies be maximized and safety improved under increasing maritime traffic and larger vessel sizes?	• Vessel • Maritime • Oil spill • Sea ice • Ice cover • Ice extent • Ocean noise	77
2.6. What exists in the unexplored areas of the ocean?	• Mapp • Exploration • Sonar • Remotely operated vehicle • Autonomous underwater vehicle • Saildrone • Hydrographic • Navigat • Exclusive economic zone	102
2.7. How can NOAA utilize and improve socioeconomic information to enhance the sustainability of ecosystem services, public engagement practices, and economic benefits?	• Divided from 3.4	118
3.1. How can unified modeling be integrated and improved with respect to skill, efficiency, and adaptability for service to stakeholders?	• Coupl AND model • Integrated model • Unified model • Downscal • Data assimilat • Earth system model • Nested model • Model uncertainty • Predictive capability • Improve model	232

NOAA *Vision (2020-2026)* Key Question	**Search Terms**	**Number of Confirmed Records**
3.2. How can earth observations be advanced and their associated platforms be optimized to meet NOAA's needs?	• Observing system • Remote Sens • Adaptive sampling • Platform • Satellite	310
3.3. How can information technology, Big Data, and artificial intelligence be utilized and improved to accelerate and transition R&D efforts and form new lines of business and economic growth?	• Big data • Data archiv • Artificial intelligence • Machine learning • Predictive analytic • Neural network • Deep learning • Reinforcement learning • Supervised learning • Genetic algorithm • Natural language process • High performance comput • Information tech	34
3.4. How can NOAA ensure its investments are informed by focused social science research and application?	• Social science • Societ • Socio • Econom • Citizen science • Decision	106
		Sum = 3025

The results were manually reviewed in Excel 2016 to ensure that projects were properly assigned to the *Vision (2020-2026)* Key Questions. Projects were assigned to more than one Key Question as appropriate. All external partner fields were queried in the NRDD on May 20, 2020. Partner fields were joined to assigned project fields using R version 3.6.0 (R Core Team, 2017) after duplicate project entries were identified and removed in Excel 2016.

The data were analyzed and visualized in Excel 2016 and R version 3.6.0. Within R, the bar plots were produced using ggplot2 (Wickham, 2009) and network diagrams were created with the Circlize package (Gu *et al*., 2014).

Results

Characterizing the current state of the NOAA R&D Enterprise related to the Vision (2020-2026) priority areas

In November 2019, the NOAA NRDD contained 3,537 active project entries (Figure 3). Of the NOAA Line Offices, Oceanic and Atmospheric Research (OAR) contained the largest percentage of projects (63.56%), followed by the National Ocean Service (NOS, 15.18%), National Weather Service (NWS, 8.17%), National Environmental Satellite, Data, and Information Service (NESDIS, 7.04%), National Marine Fisheries Service (NMFS, 5.40%) and Other (0.63%), which included the Office of Marine and Aviation Operations (OMAO), Office of Education (OEd), and Office of the Chief Information Officer (OCIO). The Line Office that is reported is the office that entered the project information into the NRDD (e.g., the primary funding office).

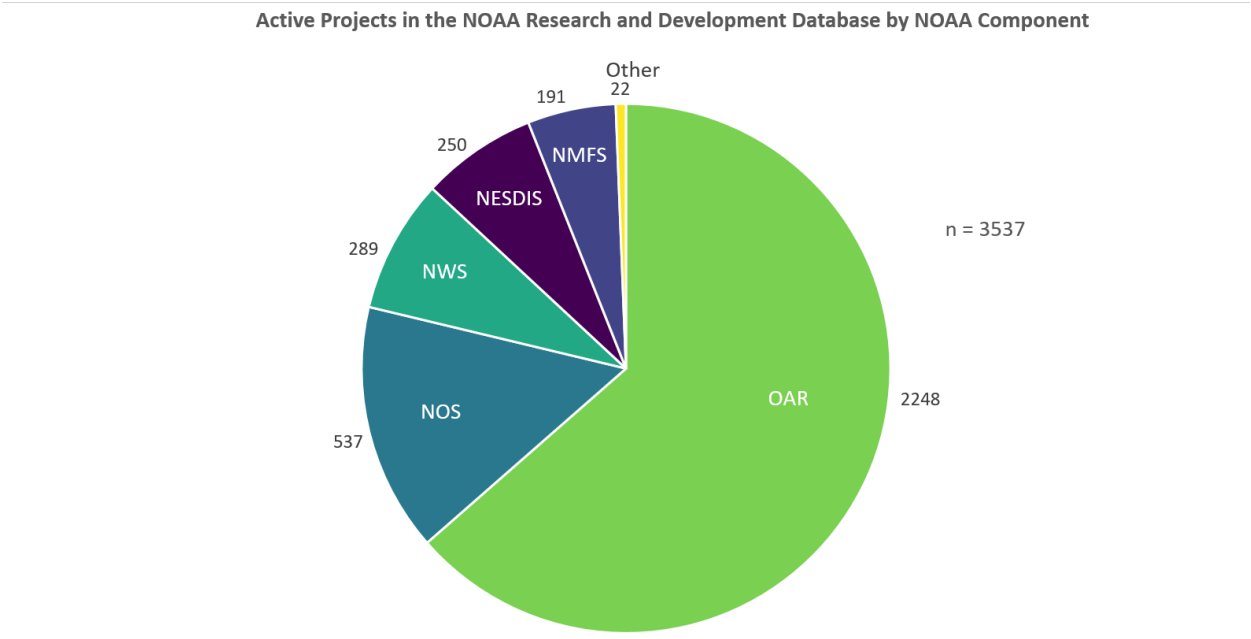


Figure 3. A pie chart of the number of active projects in the NRDD by NOAA component as of November 2019. The "Other" component is composed of the Office of Marine and Aviation Operations, Office of Education, and Office of the Chief Information Officer.

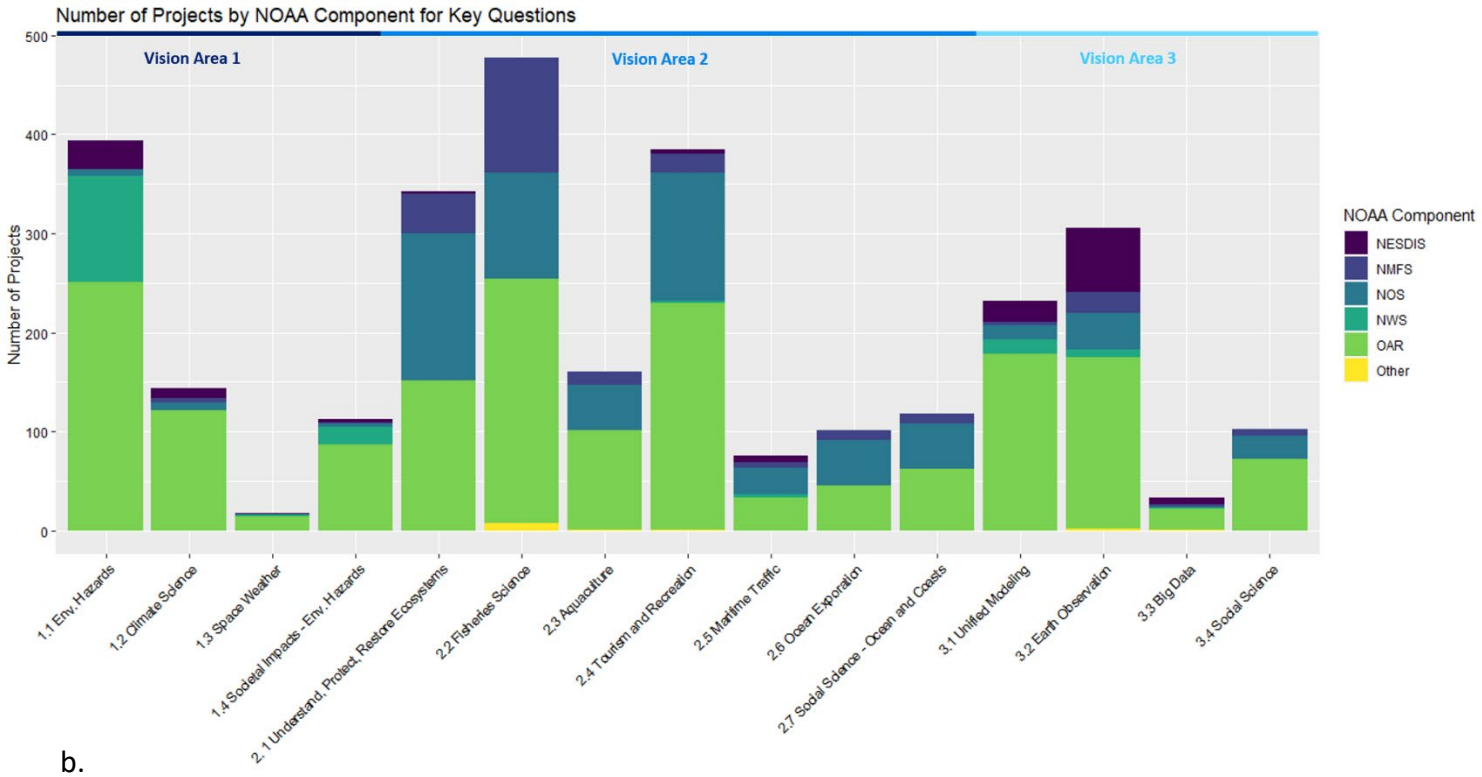
All priority topic areas from the *Vision (2020-2026)'s* Key Questions were represented in the NRDD (Table 1, Figure 4). Projects could be assigned to more than one key question, and 2,048

of the 3,537 active projects in NRDD mapped to the key questions. The comprehensiveness of projects included from this query is limited by the search terms that are used and the completeness of the project description field. It is expected that some projects will not contain the search terms from the *Vision (2020-2026)* because projects in the NRDD at the time of this query were entered before publication of the *Vision (2020-2026)* and therefore may not reflect the emerging priority areas.

The Fisheries Science (2.2) and Environmental Hazards (1.4) Key Questions had the most number of active projects represented (479 and 396, respectively) while the Space Weather (1.3) and Big Data (3.3) Key Questions had the fewest (18 and 34, respectively). When the Key Questions were categorized into the Vision Areas, Vision Area 2 was more represented (1,667 projects) than Vision Area 1 (676 projects) or Vision Area 3 (682 projects).

NOAA Line Office contributions varied by Key Question (Figure 4b). As expected based on the distribution of active projects in the NRDD, OAR had the most projects across the Key Questions. The proportion of NWS projects was highest for Vision Area 1, with the highest NMFS and NOS proportions in Vision Area 2, while NESDIS's highest proportion was in Vision Area 3.

a.


Number of Projects by NOAA Component for Key Questions
Vision Area 1
Vision Area 2
Vision Area 3
Number of Projects
500
400
300
200
100
0
NOAA Component
NESDIS
NMFS
NOS
NWS
OAR
Other
1.1 Env. Hazards
1.2 Climate Science
1.3 Space Weather
1.4 Societal Impacts - Env. Hazards
2.1 Understand, Protect, Restore Ecosystems
2.2 Fisheries Science
2.3 Aquaculture
2.4 Tourism and Recreation
2.5 Maritime Traffic
2.6 Ocean Exploration
2.7 Social Science - Ocean and Coasts
3.1 Unified Modeling
3.2 Earth Observation
3.3 Big Data
3.4 Social Science

b.

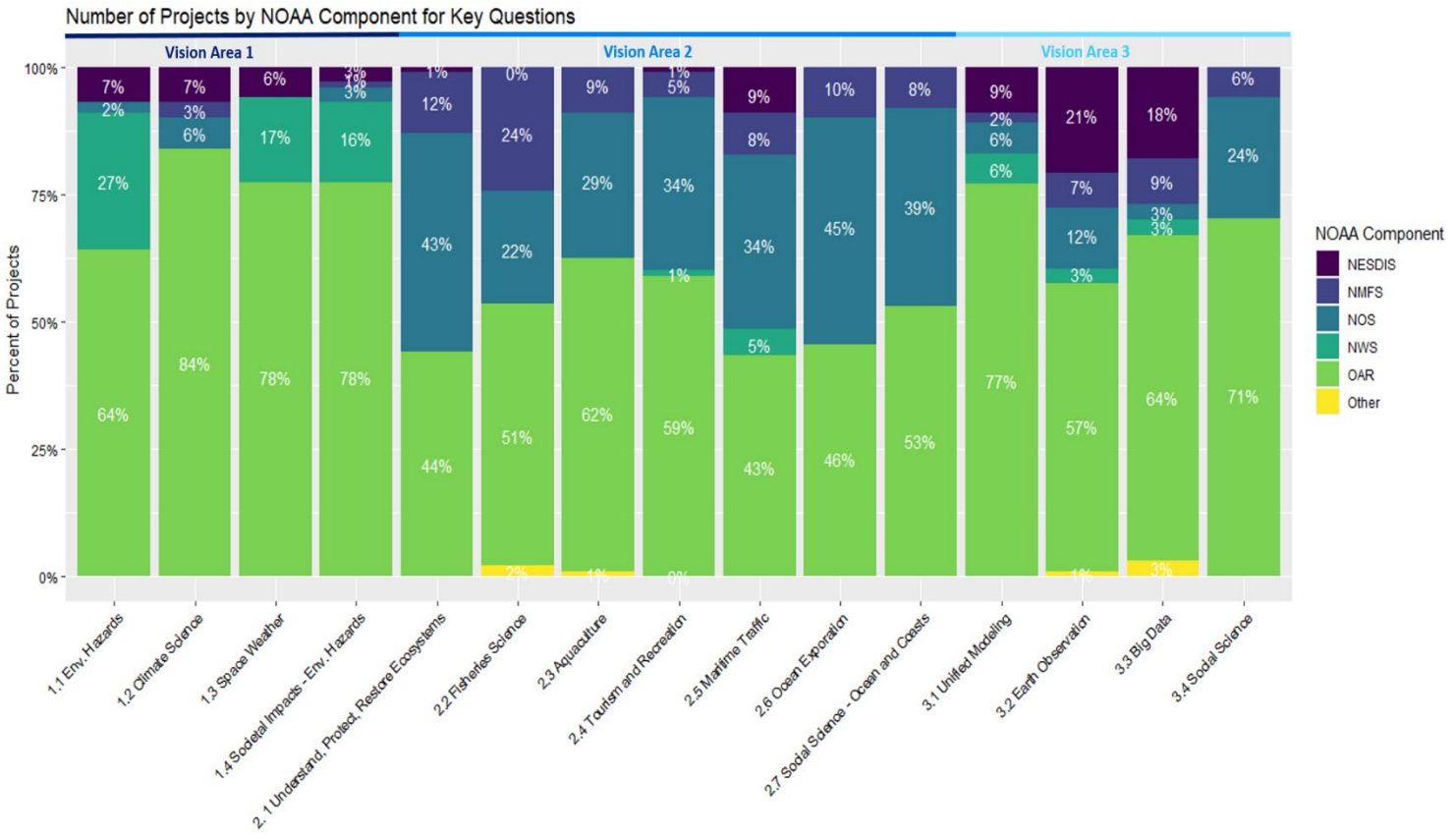

Number of Projects by NOAA Component for Key Questions
Vision Area 1
Vision Area 2
Vision Area 3
Percent of Projects
100%
75%
50%
25%
0%
NOAA Component
NESDIS
NMFS
NOS
NWS
OAR
Other
1.1 Env. Hazards
1.2 Climate Science
1.3 Space Weather
1.4 Societal Impacts - Env. Hazards
2.1 Understand, Protect, Restore Ecosystems
2.2 Fisheries Science
2.3 Aquaculture
2.4 Tourism and Recreation
2.5 Maritime Traffic
2.6 Ocean Exploration
2.7 Social Science - Ocean and Coasts
3.1 Unified Modeling
3.2 Earth Observation
3.3 Big Data
3.4 Social Science

Figure 4. The number of projects (a) and percentage contribution (b) by NOAA component for the NOAA R&D Vision Areas Key Questions. The Vision Areas for the Vision (2020-2026) are (1) Reduced societal impacts from hazardous weather and other environmental phenomena; (2) Sustainable use and stewardship of ocean and coastal resources; and (3) A robust and effective research, development, and transition enterprise.

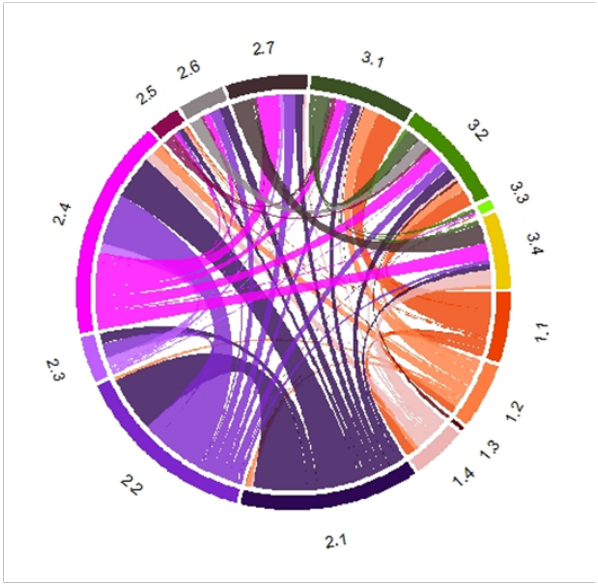
Many projects addressed more than one Key Question, with 487 projects (16%) categorized into more than one Key Question, highlighting the connectivity between Key Questions, both within and among Vision Areas (Figure 5). For Vision Area 2, a higher proportion of projects were shared within its Key Questions; whereas, for Vision Areas 1 and 3, higher proportions of projects were shared across Vision Areas.

a.

		Vision Area 1				Vision Area 2							Vision Area 3			
		1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	2.5	2.6	2.7	3.1	3.2	3.3	3.4
Environmental Hazards	1.1															
Climate Science	1.2	16														
Space Weather	1.3	0	0													
Societal Impacts - Environmental Hazards	1.4	21	10	0												
Understand, Protect, Restore Ecosystems	2.1	2	10	0	5											
Fisheries Science	2.2	1	7	0	1	123										
Aquaculture	2.3	0	1	0	0	23	32									
Tourism and Recreation	2.4	2	23	0	21	97	113	23								
Maritime Traffic	2.5	4	5	0	2	12	6	1	7							
Ocean Exploration	2.6	0	1	0	0	23	22	2	14	6						
Social Science - Ocean and Coasts	2.7	0	1	0	6	18	27	9	52	2	1					
Unified Modeling	3.1	60	33	2	5	18	14	2	23	11	1	0				
Earth Observation	3.2	36	21	6	6	24	22	4	33	8	27	3	28			
Big Data	3.3	2	0	0	2	1	2	0	4	0	0	0	5	5		
Social Science	3.4	1	8	0	35	13	9	0	39	1	0	43	8	3	0	
Sum for each key question		145	136	8	114	369	379	97	451	65	97	162	210	226	21	160
Sum for each vision area		403				1620							617			

0
1-5
6-10
11-25
26-50
51-125

b.



c.

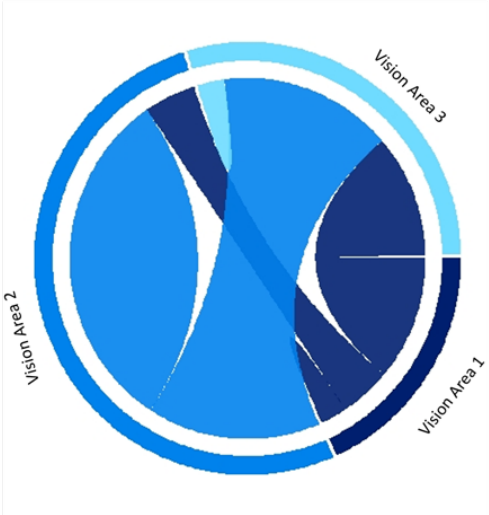


Figure 5. Matrix (a) showing the number of projects in common for each pair of Key Questions. For example, Key Question 1.1 and Key Question 1.2 have 16 projects in common. The bottom two rows show the sum for each Key Question and Vision Area, respectively, allowing for double counting of projects to occur for the Vision Area total. The data can also be displayed using network diagrams: (b) connections between the Key Questions and (c) within and between the vision areas. Each line represents a project that is shared between two or more Key Questions. The width of the line is weighted by the number of shared projects, as described in Figure 5a. Note: Figure 6b only displays connections if there are more than one shared project. All connections are non-directional.

Tracking NOAA project maturity

The distribution of project readiness levels followed a similar pattern across the three Vision Areas and fully represented the research to deployment funnel. The large number of projects at RL2 for Vision Area 2 was driven by one office within NOAA OAR.

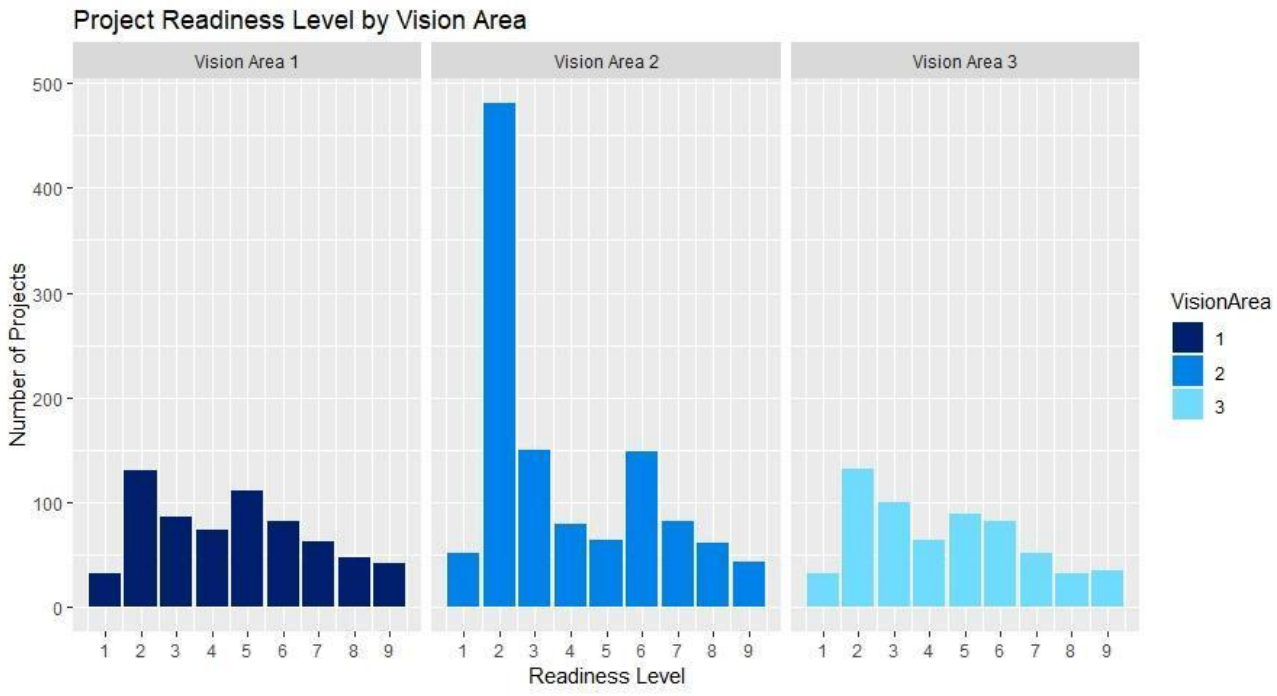


Figure 6. The project readiness level by Vision Area.

NOAA partners broadly with academia, government agencies, non-profits, and the private sector for R&D related to the *Vision (2020-2026)* (Figure 7). Cooperative Institutes (CI)/Joint Institutes (JI), Academic/School, and Federal Government partner types were the most prevalent partner types for all Vision Areas. The top 10 partner types were similar across Vision Areas, though there was variation in the order of prevalence.

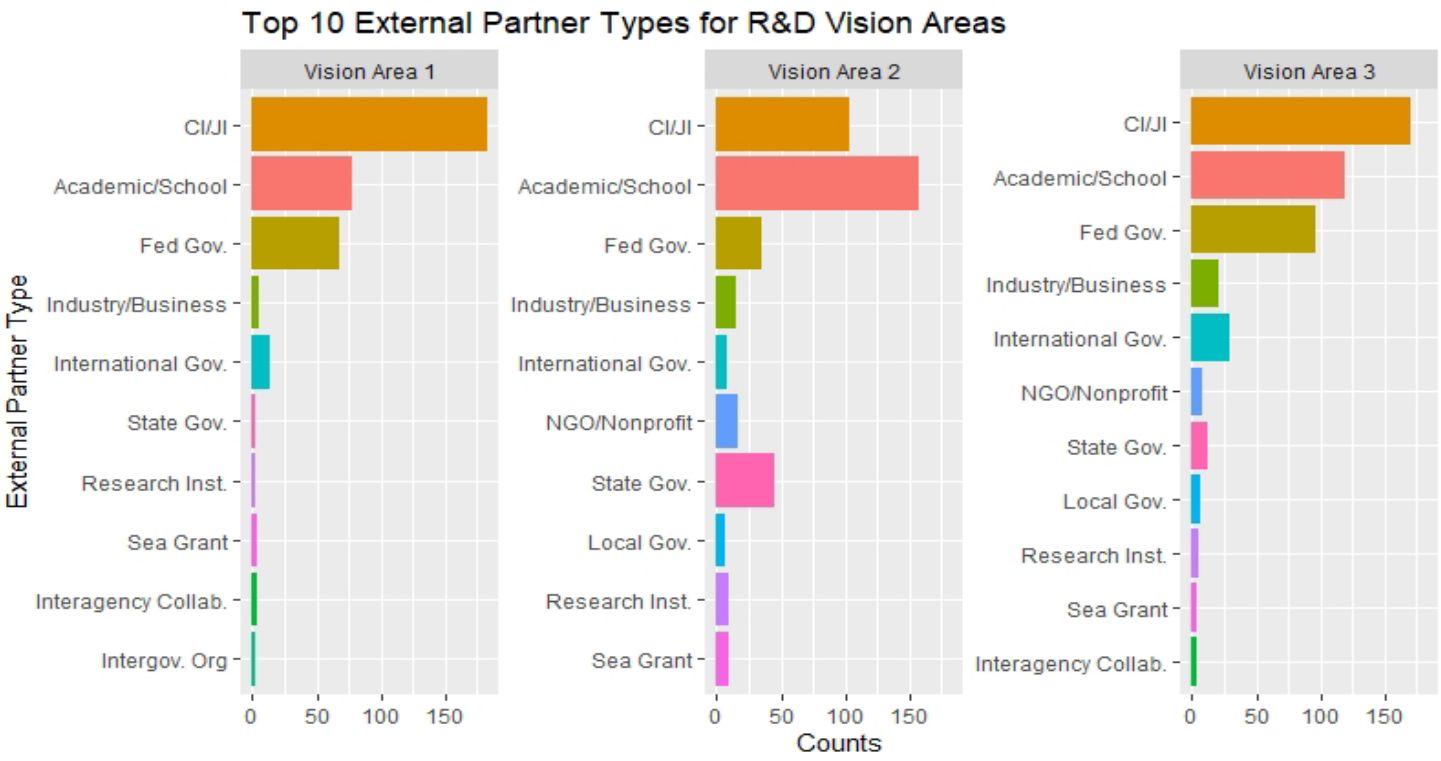


Figure 7. Top 10 partner types per Vision Area. Abbreviations stand for Cooperative Institute (CI)/Joint Institute (JI), non-governmental organizations (NGO), government (Gov.), institution (Inst.), and collaboration (Collab.)

Discussion

Status of NRDD

The NRDD compiles information on R&D projects across NOAA, providing capability and value for characterizing and assessing the state NOAA's R&D enterprise. Prior to establishing the NRDD, NOAA lacked corporate information about NOAA's scientific activities, limiting evaluation of progress toward achieving NOAA R&D Plan goals.

Given the relative newness of the database, data quality and completeness considerations exist for the NRDD results presented here. Of note, some data fields were not mandatory prior to 2020; therefore, some data are not consistently available prior to then. Similarly, query results are limited by the descriptiveness of entered data and compliance with correct identification and entry of data. The unequal distribution of project submissions across NOAA Line Offices and Staff Offices is reflected in the query results (e.g., Figure 4b). Future analyses will benefit from

ongoing efforts to enhance dataset completeness that will lead to increased accuracy in categorizing projects into priority areas and characterizing NOAA's R&D enterprise as a whole.

The NRDD provides centralized information that, otherwise, would not be available, or would be collected in an unreproducible manner and would likely suffer incompleteness. The NRDD is a long-term dataset providing a tool for comparison into the future.

Baseline state of NOAA R&D

All priority topic areas in the *Vision (2020-2026)* are currently represented by projects in the NRDD. Multiple Line Offices are represented for each Key Question, indicating that coordination, integration, and collaboration across NOAA are important for reaching the goals in the *Vision (2020-2026)*.

The network diagrams and heat map (Figure 5) showed that NOAA R&D projects transcend Key Questions and Vision Areas, which is unsurprising, given the interconnected nature of Earth system processes. The Key Questions in Vision Area 3, "*A robust and effective research, development, and transition enterprise,*" were anticipated to have the highest proportion of connections to other Vision Areas because Vision Area 3 encompasses NOAA's R&D building blocks. Vision Area 1 had the highest proportion of cross-vision-area linkages, versus within-vision-area linkages, and both Vision Area 1 and Vision Area 3 had more external linkages than internal linkages.

In general, the cross-topic connectivity highlighted in the network diagrams (Figure 5) indicates that a segregated approach to evaluation of topics in the *Vision (2020-2026)* would be ineffective. For example, advancements in data processing (e.g., through artificial intelligence) may be applicable to a range of topics, such as surveying fish and protected species, identifying extreme weather conditions, and processing satellite imagery. Similarly, progress towards the objectives in one Key Question may serve as input for other objectives. A NOAA-wide approach is key to capturing these relationships and dependencies. Using logic models centered on cross-cutting topics enables holistic evaluation, allowing for multiple Key Questions and objectives to feed into achieving a targeted societal outcome.

Readiness levels and partnerships

NOAA R&D projects spanned the spectrum of readiness levels and showed a similar distribution across Vision Areas. A slight right skew would seem to indicate a lower overall readiness level for NOAA R&D projects; however, this is consistent with and expected for an R&D maturation

model that funnels development into operations and applications, where not all R&D projects reach RL9. Also, R&D efforts targeting policy development and decision-making may have earlier endpoints and valid use, without expectation of transitioning to RL9, *i.e.,* research transition to "other" uses (R2X), skewing NOAA's R&D portfolio a bit towards lower RLs.

External engagement is an important component of NOAA's R&D enterprise, and many different partners play a key role for carrying out the R&D detailed in the *Vision (2020-2026)*. Cooperative Institutes and Joint Institutes, Federal and State governments, and academia were most represented as partner types for the projects in this analysis. Future projects could focus on a more specific component of R&D partnerships within and across Vision Areas. For example, it could be interesting to analyze how Cooperative Institutes contribute to NOAA's R&D portfolio for a given topic (e.g., social science) or compare the project transition types with different partner types to see if patterns emerge (e.g., it may be hypothesized that business/industries partnerships will yield a greater proportion of projects that transition to commercialization).

Next steps

The NRDD baseline provides a foundation for setting more-informed progress-to-plan targets for the *NOAA R&D Vision Areas* by sparking questions, such as:

- In the next seven years, how might/should the distribution of projects shift across priority areas?
- To what extent and where does NOAA science reach across Vision Areas?
- For a particular priority area, at what rate do NOAA projects mature to the next readiness level?
- For specific R&D priority topic areas, with which partner types does NOAA most commonly engage?

The data obtained from this baseline analysis can be used to populate NOAA R&D logic models for tracking the progress that is made toward the goals described in the *Vision (2020-2026)*. For example, the projects that align with each Key Question can be mapped as "R&D Outputs" with transitions, milestones, and outcomes in the operational space that contribute to the societal outcome. In this way, the *NOAA R&D Vision Areas* objectives are traced throughout the logic model, in both anticipated and actual impacts. During the lifetime of the *Vision (2020-2026)*, projects will reach milestones, transition, create output, and contribute to outcomes, which will influence user needs/requirements and scientific insight, prompting new R&D projects. Logic model metrics aim to capture this evolution and changes and are expected to reflect resulting

shifts in project distributions and readiness levels. The addition of other data sources will be important to supplement the use of counts of NRDD projects as a basis for comparison because project size/scope is not standardized across NRDD entries and resource requirements and availability vary. In addition, focusing on the number of projects does not take into account the impact of a given project. The approach taken here provides only a cursory look at the utility of the NRDD for informing logic model evaluation, but these data provide a starting point from which to measure future progress for the *Vision (2020-2026*).

Expanding the utility of this NOAA R&D characterization baseline, future analyses could add metrics and integrate data sources beyond the NRDD (e.g., Annual Operating Plans) to increase applicability to the logic model. As relationships between drivers, projects, and indicators are more explicitly detailed, NOAA increasingly will be able to identify key junctures, achievements, and areas needing additional focus and resources.

Summary

The NOAA Research and Development Database serves as a valuable tool for characterizing and assessing the state of NOAA's R&D enterprise. The information in the database was used to determine the distribution of projects, Line Office contributions, readiness levels, and partner types for the Key Questions and Vision Areas in the *NOAA R&D Vision Areas: 2020-2026*. The NRDD information can be used to identify and highlight relationships and dependencies between NOAA science and societal outcomes. This information valuably informs planning, target setting, and progress evaluation with respect to achieving the goals stated in the *Vision (2020-2026)*. Through such tools and assessments, NOAA will be better equipped provide continuing high-quality Earth system science that meets the Nation's needs.

Citations

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Appendix 1. List of confirmed NRDD Project IDs resulting from the search term query

The full list of NRDD projects IDs related to this document (as reported in Table 1) can be found here.

Appendix 2. List of NRDD fields introduction and mandatory years as of May 2020. Field names with an asterisk indicate data fields that were used in this analysis.

NRDD Field Name	Introduced in	Mandatory Since
NRDD Project ID*	2017	2017
NRDD Status	2017	2017
Current RL*	2017	2017
Project Title*	2017	2017
LO*	2017	2017
Office*	2017	2017
Division	2017	2017
Alternate Project ID	2017	2017

NRDD Field Name	Introduced in	Mandatory Since
Project Description	2017	2017
Project Benefits*	2017	2017
Project Outcome*	2017	2017
Transition Plan (y/n)	2017	2017
R2X Type*	2017	2017
Record Creator	2017	2017
Planned Project Start*	2017	2017
Planned Project End*	2017	2017
Actual Project Start	2017	2017
Actual Project End	2017	2017
PI First Name	2017	2017
PI Last Name	2017	2017
PI Email	2017	2017
PI Affiliation	2017	2017
PI Phone	2017	2017
NOAA POC First Name*	2017	2017
NOAA POC Last Name*	2017	2017
NOAA POC Email*	2017	2017
NOAA POC Affiliation	2017	2017
NOAA POC Phone	2017	2017
Current RL Category	2017	2017
Current RL Description	2017	2017
Source Database	2017	2017
Last Record Update	2017	2017
Updated By	2017	Automatically generated
Alternate Project ID Type	2017	Optional

NRDD Field Name	Introduced in	Mandatory Since
Hurricane Supplemental	2018	2019
Economic Valuation	2019	2019
PI Name	2017	2017
NOAA POC Name	2017	2017
Approved Keywords	2017	2019
Provisional Keywords	2017	2019
Milestone	2017	2019
Milestone AOP	2017	2019
Milestone Planned Date	2017	2019
Milestone Actual Date	2019	2019
Final Deliverable	2017	2017
Final Deliverable Type	2017	2017
Final Deliverable Planned Date	2017	2017
Final Deliverable Actual Date	2017	2017
Final Deliverable AOP	2017	2017
Partners*	2017	2019
Stakeholders	2019	2019
Internal or External Organization	2017	2019
External Organization Name	2017	2019
External Organization Type*	2019	2019
External Organization Scale	2019	2019
External Organization State/Country	2019	2019
Internal Organization Name	2017	2019
Team Member Role	2017	Optional
Team Member First Name	2017	Optional
Team Member Last Name	2017	Optional

NRDD Field Name	Introduced in	Mandatory Since
Team Member Email	2017	Optional
Team Member Affiliation	2017	Optional
Team Member Phone	2017	2019
Performance Measure Type	2017	2019
Performance Measure	2017	2019
Performance Measure FY	2019	2019
Performance Measure LO	2017	2019
Planned Transition Date	2019	2019
Actual Transition Date	2019	2019
Adopters	2017	2019
Reason No Plan	2019	2019
External Adopter State/Country	2019	2019
External Adopter Scale	2019	2019
External Adopter Type	2019	2019
NOAA or External Adopter	2017	2019
Expired DOC SP	2017	2019
Current DOC SP	2019	2019
5-Year R&D SP	2017	2019
Next Gen SP	2017	2019
NOAA Funding Lines	2019	2019
Grant/Contract Awards	2019	2019
Annual Planned Direct Funds	2017	2019
Total Planned Direct Funds	2017	2019
Annual Actual Direct Funds	2019	2019
Total Actual Direct Funds	2019	2019
Total Ship Days	2017	2019

NRDD Field Name	Introduced in	Mandatory Since
Total Aircraft Hours	2017	2019
Total HPC Hours	2017	2019
Total Observing System Days	2019	2019
Total Non-Federal Salary $	2019	2019
Additional Leveraged Resource Name	2019	2019
Additional Leveraged Resource Value	2019	2019
RL Tracking	2018	2019