NOAA Technical Memorandum OAR ORTA-001

Analysis of OAR Transition of Research and Development (FY19)

Francis Choi
Laura Newcomb
Fiona Horsfall
Gary Matlock

NOAA/Laboratories and Cooperative Institutes
Silver Spring, Maryland
December 2021

noaa NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION / Office of Oceanic and Atmospheric Research

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NOTICE

Abstract

This is the fourth installment of the National Oceanic and Atmospheric Administration (NOAA) technical memorandum on Oceanic and Atmospheric Research (OAR) transitions. This report analyzed and summarized all OAR transitions (defined as research to operations, applications, commercialization, other uses, or R2X) in fiscal year 2019. Using methods established by previous reports, the FY19 report examined how transitions are reported in OAR, and if reported transitions are accurate. Further analysis of the FY19 transitions looks at the impacts of the transition through its function, output, application, recipients, and strategic goals.

Overall, 77 transitions were reported to OAR in fiscal year 2019. Only seven reported transitions were not consistent with the definition of transition found in NOAA Administrative Order (NAO) 216-105B. With 91% accuracy rate, of the four installments of NOAA technical memoranda on OAR transitions, FY19 yielded the highest accurately reported transitions. The high accuracy could be related to the recent emphasis on R&D transitions, transition plans, and understanding readiness levels (RLs).

The majority of the projects that were incorrectly reported as transitions are projects that focus on transitioning knowledge. These transitions were considered as incorrect because they lacks identifiable recipients. This issue was also highlighted in the previous technical memorandum (Certner et al., 2020). Developing transition plans for OAR R&D, as a tool to improve R&D project management, would be a first step to aid in identifying recipients for R&D transitions.

Introduction

Transition of research and development (R&D) is the transfer of knowledge or technology from a research or development setting to a capability ready setting for an operation, application, commercial product or service, or other uses. Having R&D outputs transition into use, NOAA continues to provide innovative science that supports better management of the environment, both nationally and internationally (OAR Strategy for 2020-2026). As described in the NOAA administrative order on research and development transitions (NAO 216-105B), an integrated transition enterprise linking research, development, demonstration, and deployment is a key process in measuring the progression and accomplishment of NOAA; to demonstrate the various products that NOAA provides as science-based services and stewardship agency. For this reason, R2X information is becoming more relevant to NOAA leadership as various reports have queried R2X data as a means to illustrate tangible outcomes that serve NOAA's mission and benefit the American people.

Definition of R&D R2X

R2X is a term used to cover a broad category of R&D transition, including transition to **operations** (**R2O**), transition to **applications** (**R2A**), transition to **commercialization** (**R2C**) and transition to **other uses** (**R2U**). R2U includes output such as policy, regulations, resource management, public education and outreach, etc.

For the Office of Oceanic and Atmospheric Research (OAR), transitions are the results of the R&D work that was conducted to meet OAR's strategic plan as NOAA's research foundation for understanding the complex systems that support the atmosphere and the oceans. Reporting transitions at OAR is crucial to understand the entire NOAA R&D enterprise. If transitions are under reported, it undermines the value of OAR contributions. To minimize under reporting transitions, technical memoranda, reports, and seminars from OAR are produced with the focus on improving planning, monitoring, and facilitating transitions across the entire agency.

Information from past technical memoranda (Sen 2015, Kroll et al. 2018, Certner et al. 2020) on OAR transitions indicates that OAR's understanding of what constitutes a transition has improved from 2013 to 2018, but some confusion in transition fundamentals still remains. The confusion is caused by the gap in knowledge of the technical definition of transition in OAR and across NOAA. At NOAA, R&D progression to transition is largely measured by readiness levels (RLs). In the simplest form, R&D transition specifically refers to the movement from RL8 to RL9 (Figure 1). This definition, even with the use of different tools (such as the decision tree in Certner et al. 2020) still results in confusion and misunderstanding, especially for unique types of transition, such as transitions that are not trinket-based.

Following is an analysis of fiscal year 2019 (FY19) transitions in OAR. The main focus areas of this analysis are 1) to examine whether transitions are reported correctly or incorrectly, 2) to identify potential reasons for misidentified transitions, and 3) to present trends in transitions since 2013. This paper will continue to address the confusion of defining transition and provide recommendations to better identify transitions in R&D.

Methodology

Data were collected from the FY19 OAR Annual Operating Plan (AOP) and the NOAA Research and Development Database (NRDD) for information on OAR projects that transitioned in FY19 (October 2018 - September 2019).

Data Collection

Annual Operating Plan

Every fiscal year, OAR Annual Operating Plan data are collected by the OAR's Formulation and Performance Management Branch's Strategic Management Team. This data is collected through requests to OAR labs and programs to submit planned milestones and project information at the beginning of the fiscal year and through an update by the end of the fiscal year in quarter four (Q4). Project information includes transition information for each project as it moves through R&D lifecycle phases. The collected data is compiled and stored as an excel spreadsheet on the OAR Strategy Management Team's website. Using R 4.0.2 (R Core Team, 2020) and the tidyverse (v1.3.0; Wickham et al., 2019) package, the AOP data that is applicable to transitions are sorted and extracted. Extracted data includes Financial Management Center (FMC), Identifier, Description, Transition Year, OAR Partners, Customer Name, Purpose, Moved From, and Moved To. Of the 227 projects reported to the AOP, 63 projects were reported as transitioned to "Operations" in FY19.

NOAA R&D Database (NRDD)

In addition to the AOP data, the NRDD was also a source for FY19 transition data. The NRDD is a secure, web-based enterprise tool to house project data for all R&D conducted by NOAA. Two data collections, in May and December, are requested by the NRDD management team. In addition, at any time throughout the year, R&D projects can be added and updated to the database. For this transition report, data were downloaded through the NRDD's Query Builder function. OAR projects with RL9 completion between October 2018 and September 2019 were selected and filtered for download. NRDD data fields such as project description, title, transition adopters, etc. were compiled and integrated to the AOP dataset by mapping the similarities to avoid duplicate entries in the dataset.

Categorizing and Coding Transition information

In total, 77 transitions (63 from the AOP, 17 from the NRDD, 3 overlapping both sources) were reported by OAR labs and programs in FY19. Projects were categorized following the qualitative labeling system outlined in Sen 2015. Additional coding was done to categorize NOAA Science & Technology focus areas, a priority of the current NOAA administration. NOAA Science & Technology focus areas include: Citizen Science Strategy, Data Strategy, Cloud Strategy, Uncrewed Systems Strategy, Artificial Intelligence Strategy, and 'Omics Strategy.

Annual Transition trends

Annual transition trends were also collected for this report. The number of FY19 transitions per FMC and FY19 transitions to OAR 2013-2018 Strategy were combined with the same data from 2013-2018. 2013-2018 data were extracted from previous technical memoriam reports on transitions. Methods to collect transition data between 2013 and 2018 were variable, with a combination of annual AOPs, NRDD, and manual data calls. Entries that did not list a date were excluded from this dataset.

Results

Transition Accuracy

Overall, 77 transitions were submitted in FY19 using both the AOP and NRDD as data sources (Figure 2). Using the qualitative labeling system outlined in Sen 2015, 70 of the transitions submitted were accurate transitions, while seven projects were considered as misidentified. The AOP yielded 63 FY19 transitions, 55 accurate and five misidentified, while the NRDD yielded 17 FY19 transitions, 12 accurate and two misidentified. There was an overlap of only three transitions between the AOP and the NRDD.

Percentage of accurate transitions were calculated for FY19 and combined with the previous transition data from 2013-2018. Of the 77 projects that were reported as transitioned to operation, 91% (70) were accurate (Figure 2). For FY13, 53% of projects fit the OAR R&D transition definition, 35%, 86%, 65%, 71%, and 86% fit the OAR R&D transition definitions for FY14, FY15, FY16, FY17, and FY18 respectively. Number of accurately reported transitions increased 5% from the previous year.

FY19 transitions were further broken down by the 16 OAR FMCs (Figure 3). Transitions per FMC ranged from 12 for AOML to zero for PMEL and OER. The seven misidentified transitions are from three FMC, with NSGO having the most misidentified (5). Number of transitions over time, 2013-2019 are also shown for each of the 16 OAR FMCs (Figure 4).

FY19 Transition Statistics

Subsequent figures characterize the 70 FY19 accurate transitions, including R&D activities (Figure 5), output type (Figure 6), recipient type (Figure 7, Figure 8), and application type (Figure 9). Additional information on how these transitions matched with NOAA strategy initiatives are outlined by NOAA strategic goal 2013-2018 (Figure 10, Figure 11), and NOAA Science and Technology focus areas (Figure 12).

Discussion

Understanding transition

The main purpose of this technical memorandum is to identify accurately reported FY19 OAR R&D transitions and more importantly to explore whether misidentified transitions are reported and why they might be misidentified. It is important to understand that R2X transition specifically refers to the transition from RL8 and RL9.

The seven misidentified transitions are not transitions for two main reasons. First, six of the seven projects are knowledge transfer projects that have not completed the transition into deployment (RL9). Unlike the other knowledge transfer projects that were accurately identified as transitions, these six projects did not include information about their intended end user(s). Many knowledge transfer transitions have multiple end users but in order for projects to fully transition into R2X, information must be provided to identify the goal, the success, and the transfer of the output and its documentation to an intended user or groups of intended users. As described in previous technical memoranda, the deliverables from projects with no intended end users are considered as scientific or pre-operational service delivery rather than true transitions (Sen 2015). The purpose of identifying an intended end user is not only to foster communication and partnership between the R&D team and the users but also can confirm how the knowledge will be used and implemented once it is transitioned.

The other project that was misidentified as a transition was waiting for patent approval. At the current stage of the project, this project has not fully transitioned into commercialization even though the final output is complete. It sits at RL8 (demonstration) because the required documentation, the patent document, is not complete and therefore the project is not ready to be transferred to the intended user. When the patent document becomes official, the project can then fully be transitioned; moving from RL8 to RL9.

Even with seven misidentified transitions, OAR in FY19 continues to improve in reporting transitions correctly. Comparing the percentage of accurate transitions reported by year since FY13 (Figure 2), FY19 has the greatest percent of correct reports. The more striking result from this report is not the number of misidentified transitions, but the lack of overlapping projects found between the two methods of data collection. Only three R&D projects were found to overlap between the OAR's AOP and the NRDD. Further considerations should focus on developing and socializing a centralized location to gather, store, and share R&D information. A centralized location for all R&D data can foster consistency in reporting out and identifying OAR R&D information.

Understanding the impact of FY19 OAR R&D transitions

Using the 70 accurately reported R&D transitions, the following sections illustrate OAR's impact on NOAA's mission through the R&D enterprise.

OAR FMCs have variable transition reporting

FY19 had a wide range of accurate transitions among the OAR FMCs, with AOML yielding the greatest number of transitions at 12 (Figure 3). Two FMCs (OER and PMEL) did not have any transitions in FY19. Tracking this data since 2014 reveals that reported transitions are variable across FMCs and no FMCs are consistently reporting the same amount of transitions annually (Figure 4). This is in line with the nature of R&D and funding cycles, where a batch of projects are funded, started, and completed at the same time. An example is Uncrewed Systems Research Transition Office (UxSRTO), where no projects transitioned since 2013 but in FY19, 11 R&D projects were reported to be transitioned.

OAR transitions have various recipients with NOAA being its biggest customer

In FY19, OAR R&D transitions mostly occurred internally within NOAA (42% - see Figure 7). When the "multiple users" category is broken down into the specific users, internal transitions to NOAA are even greater at 45% (Figure 8), showing that even for R&D that transfer to multiple users, NOAA is still one of the recipients. These results continue to support the importance of OAR R&D. OAR demonstrates the continued effort to collaborate with other NOAA Line Offices, to improve operations, applications, and knowledge conducted by these line offices. It is worth noting that while the majority of the OAR transitions are supporting NOAA internally, there are many transitions that directly serve the general public (10%), private sector (1%), and academia (6%). OAR continues to act as an R&D portal to both internal and external science-based customers.

OAR transition applications are mostly to promote environmental intelligence

In FY19, a large proportion of OAR transitions were applied to promote environmental intelligence (Figure 9). Specifically, this refers to information measured, gathered, compiled, exploited, analyzed, and disseminated to characterize the current and/or future state of the environment at a given location and time. Many of these products were transitioned to NWS and NESDIS and are used to improve weather forecasting and monitoring. This speaks to the strength of the OAR's mission to provide the research foundation to understanding the complex systems that support our planet.

OAR transitions meet all OAR and NOAA strategic plans

As a mission-driven agency, it is important to align R&D to NOAA's overarching objectives. In FY19, the 70 accurate OAR R&D transitions fitted into all of the 2013-2018 OAR R&D strategic plans (Strategic Plan for NOAA's Office of Oceanic and Atmospheric Research), with the Healthy Oceans strategic plan as the most prominent strategy in FY19 (Figure 10).

This memo reviews how OAR transitioned projects fit in with the 2013-2018 OAR R&D strategic plans. Even though transitions drawn from the annual report are variable across FMCs, it is noticeable that no distinct strategic plan was consistently favored or, more importantly, ignored year after year in OAR (Figure 11). Overall, internal NOAA (NWS & NESDIS) R&D transitions for weather were the most numerous, but transitions to other areas of NOAA's mission were also represented.

In addition to OAR strategic plans, NOAA Science and Technology (S&T) areas are also coded to the FY19 transitions. In FY19, four of the six S&T areas were met, with the Data focus area being the most prominent (Figure 12). These transitions demonstrate OAR's part in meeting NOAA's S&T goals.

Conclusion

By describing the different aspects of the FY19 transitions (FMCs, recipients, applications, and strategies met), these types of transition memos continue to illustrate the impacts of OAR's R&D to NOAA's mission and the American people. Even though FY19 saw the lowest percentage of misidentified transitions since 2013, several considerations are presented here to prevent further misidentifying R&D transitions in future years.

Clarify and identify knowledge transfer

The majority of the misidentified transitions in FY19 (6) are related to knowledge transfer. As knowledge transfer is an integral part of NOAA's R&D enterprise, it needs to be correctly identified as a transition. OAR continues to clarify definition and understanding of knowledge transfer. However, basic guidelines to help identify accurate transitions for knowledge transfer are:

1) Identify outputs of the proposed R&D goal.
2) Identify the target of the transition, specifically, an intended user.

These guidelines can help foster partnership with the end user and help identify application of the knowledge after the transition.

Use of transition plans

Another tool to prevent under reporting transitioned projects is the use of transition plans. Transition plans are required in OAR for R&D projects beyond RL4 (OAR Delegations and Directives, 2018). These documents are crucial in project management to create agreement between the developer and the recipients (NAO 216-105b). Transition plans help both the researcher and end user plan R&D project goals, progressions, requirements for transitions, and successes. Development of transition plans is important for robust project management within NOAA.

Literature cited

Certner, R., Newcomb, L., and Matlock, G. (2020) Analysis of OAR Transition of Research and Development (FY18). NOAA Technical Memorandum OAR LCI-002.

Kroll, I., Newcomb, L., Moses, C. and Matlock, G. (2018) Analysis of OAR Transition of Research and Development (2014-2017). NOAA Technical Memorandum OAR LCI-001

National Oceanic and Atmospheric Administration Research Council. Strategic Plan for NOAA's Office of Oceanic and Atmospheric Research. United States Department of Commerce. 2014.

National Oceanic and Atmospheric Administration. Oceanic and Atmospheric Research Delegations and Directives Circular 216.7. United States Department of Commerce. 2018.

National Oceanic and Atmospheric Administration. NOAA Administrator Order 216-105B: Policy on research and development transitions. United States Department of Commerce. October 2016.

National Oceanic and Atmospheric Administration. NOAA Science & Technology: Accelerating Innovation in the 21st Century. United States Department of Commerce. September 2020.

R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Sen, A. (2015). What Does "Transition" Mean? A Qualitative Analysis of Reported Transitions at OAR. NOAA Technical Memorandum OAR PPE-5.

Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L., François, R., Grolemund, G., Hayes, A., Henry, L., Hester, J., Kuhn, M., Pedersen, T., Miller, E., Bache, S., Müller, K., Ooms, J., Robinson, D., Seidel, D., Spinu, V., … Yutani, H. (2019). Welcome to the tidyverse. Journal of Open Source Software, 4(43), 1686.

Figures

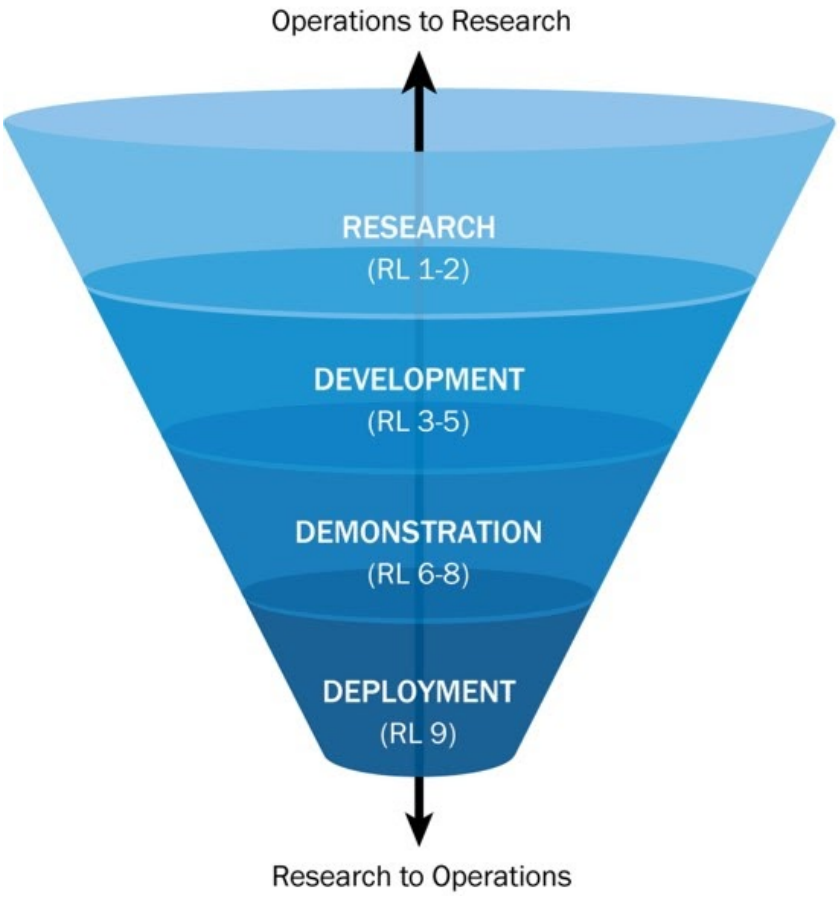

Figure 1. Distribution of OAR projects by Readiness Levels (RLs)

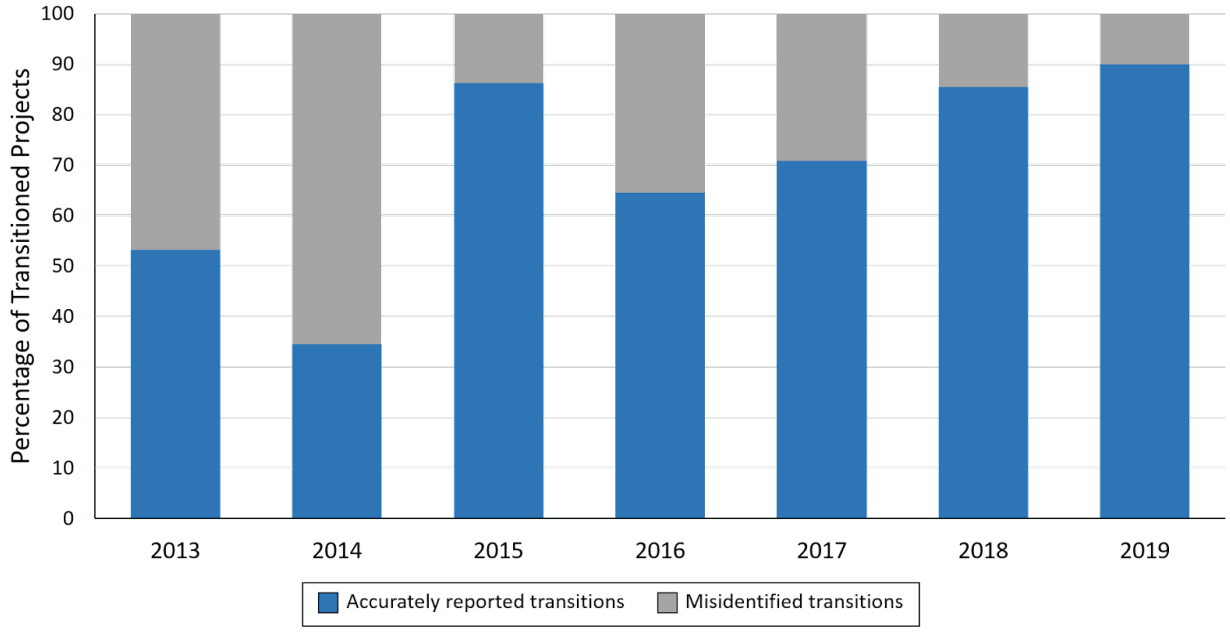

Figure 2. Accurately reported and misidentified transitions (FY13-FY19). Accurately reported transitions increase year after year from 53% in 2013 to 91% in 2019.

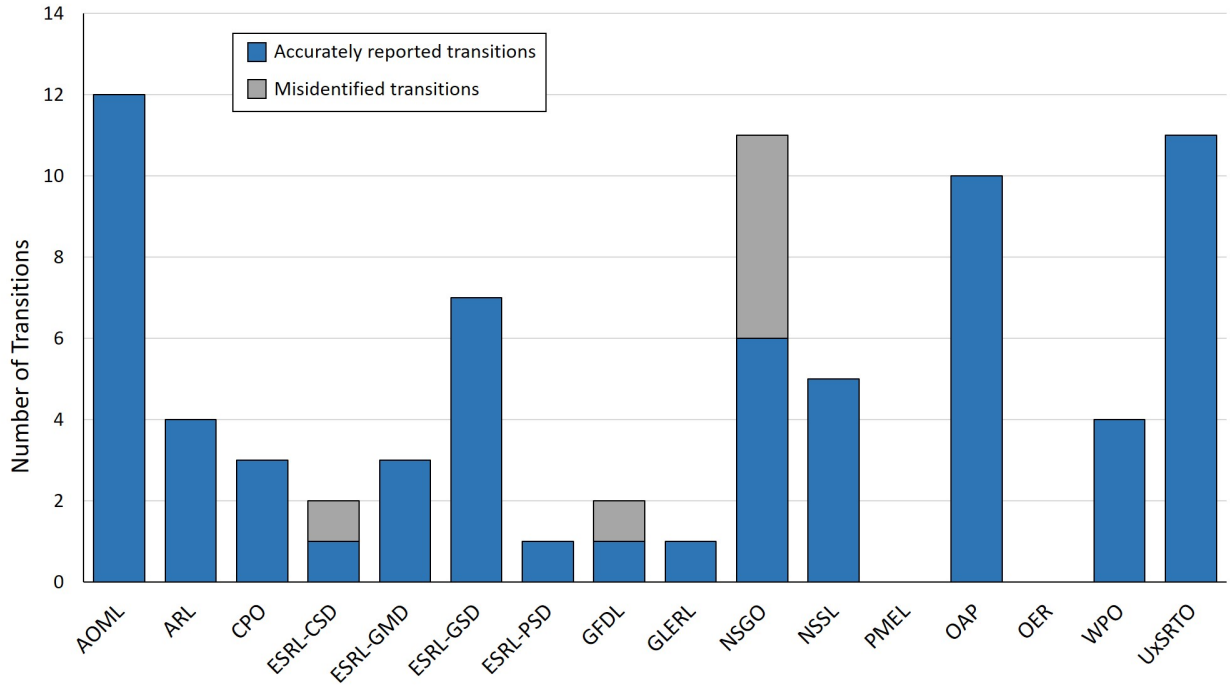

Figure 3. FY19 transitions by FMCs. The 77 FY19 transitions were categorized by their FMCs. Of the 16 FMCs, AOML facilitated the most transitions (12). PMEL and OER reported zero but this might be the result of underreporting transition to the AOP and the NRDD.

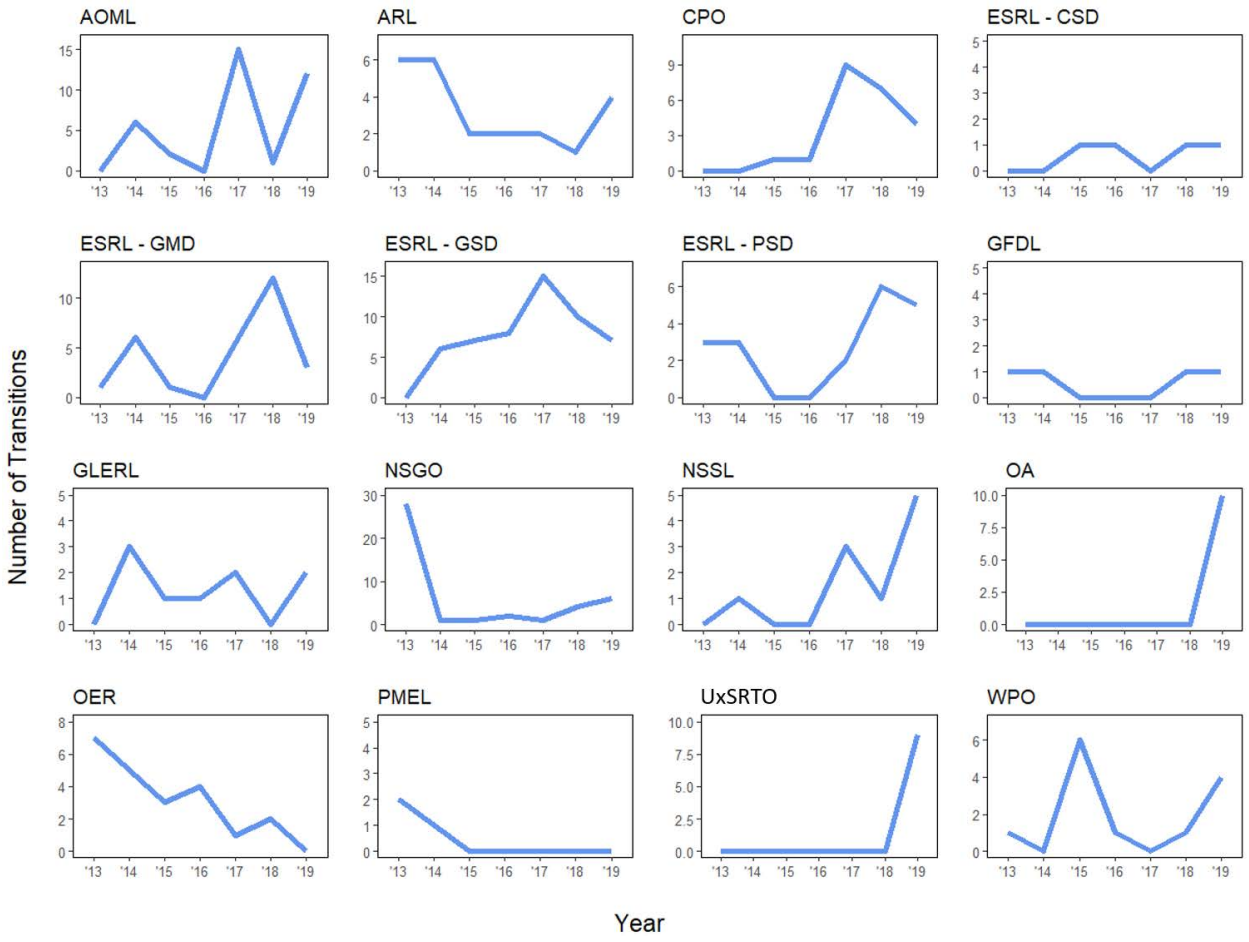

Figure 4. OAR Transitions by FMCs (FY13-FY19). 341 total transitions occurred in OAR from 2013-2019. These transitions are categorized amongst FMCs to show the rate of transitions. There is a lack of distinct patterns with transitions across FMCs.

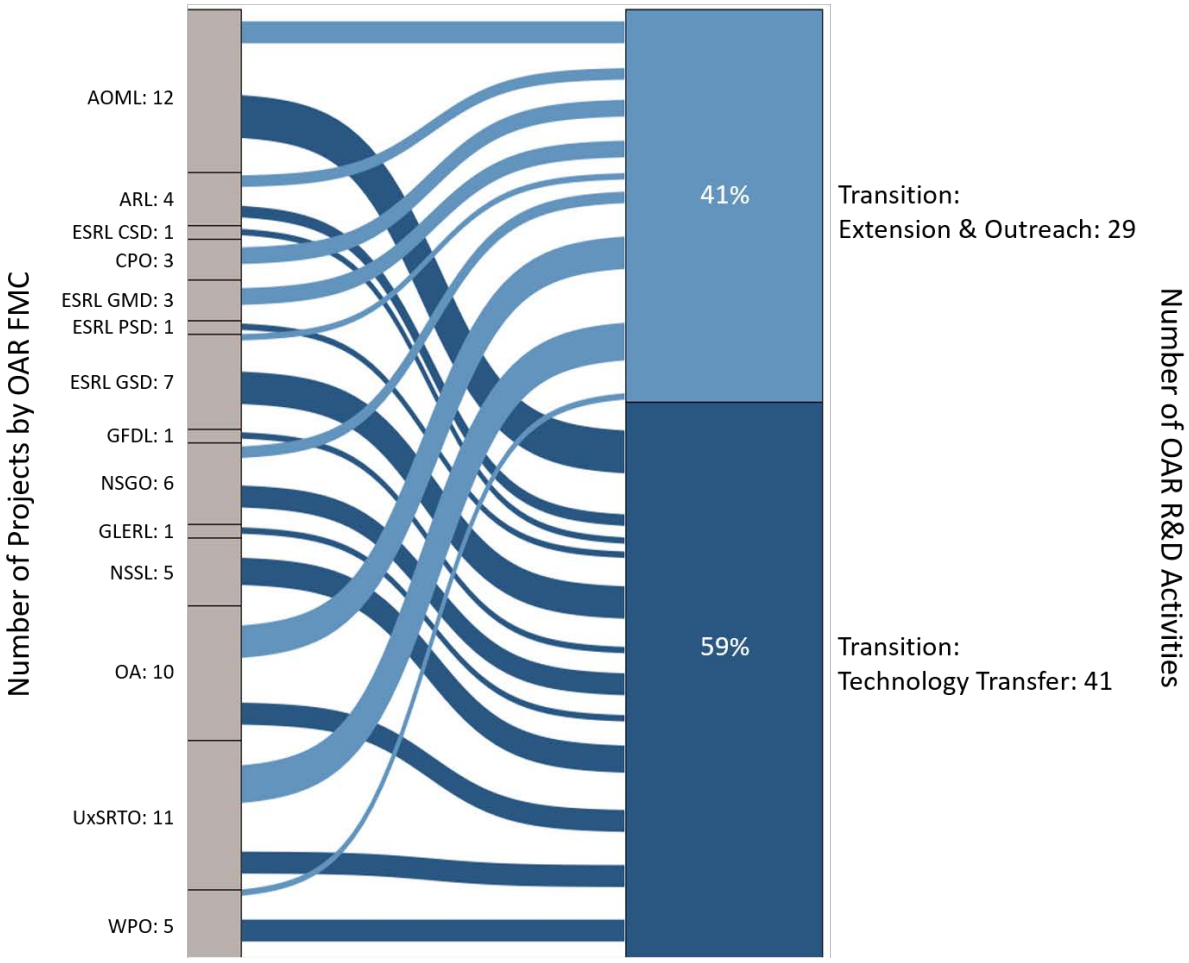

Figure 5. FY19 R&D activities by OAR FMCs. The 70 accurately reported transitions were categorized into transition activities: Technology Transfer and Extension and Outreach. Of these accurately reported transitions, 41% were categorized as Extension and Outreach and 59% were Technology Transfer.

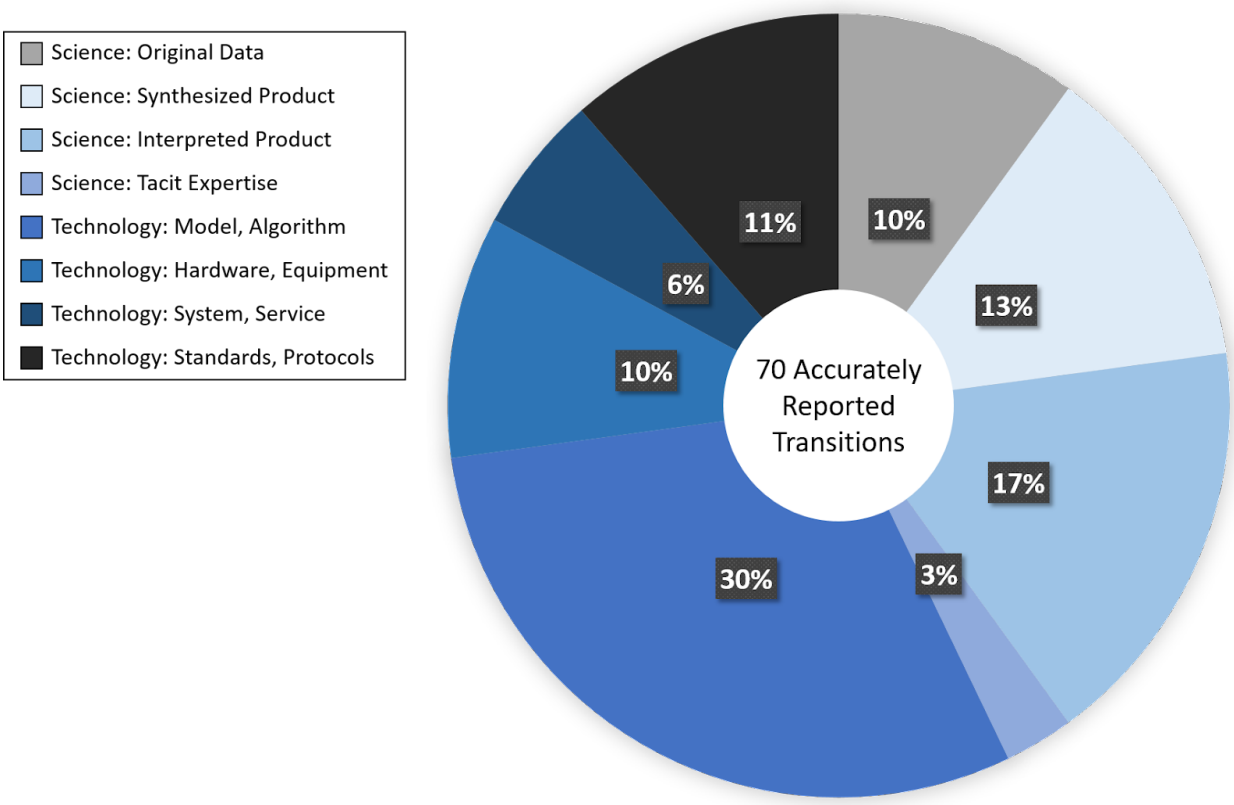

Figure 6. FY19 OAR R&D Outputs. The 70 accurately reported transitions were categorized into output types. As in previous years, the largest category of output was in "Model, Algorithm", which included model updates or improvements.

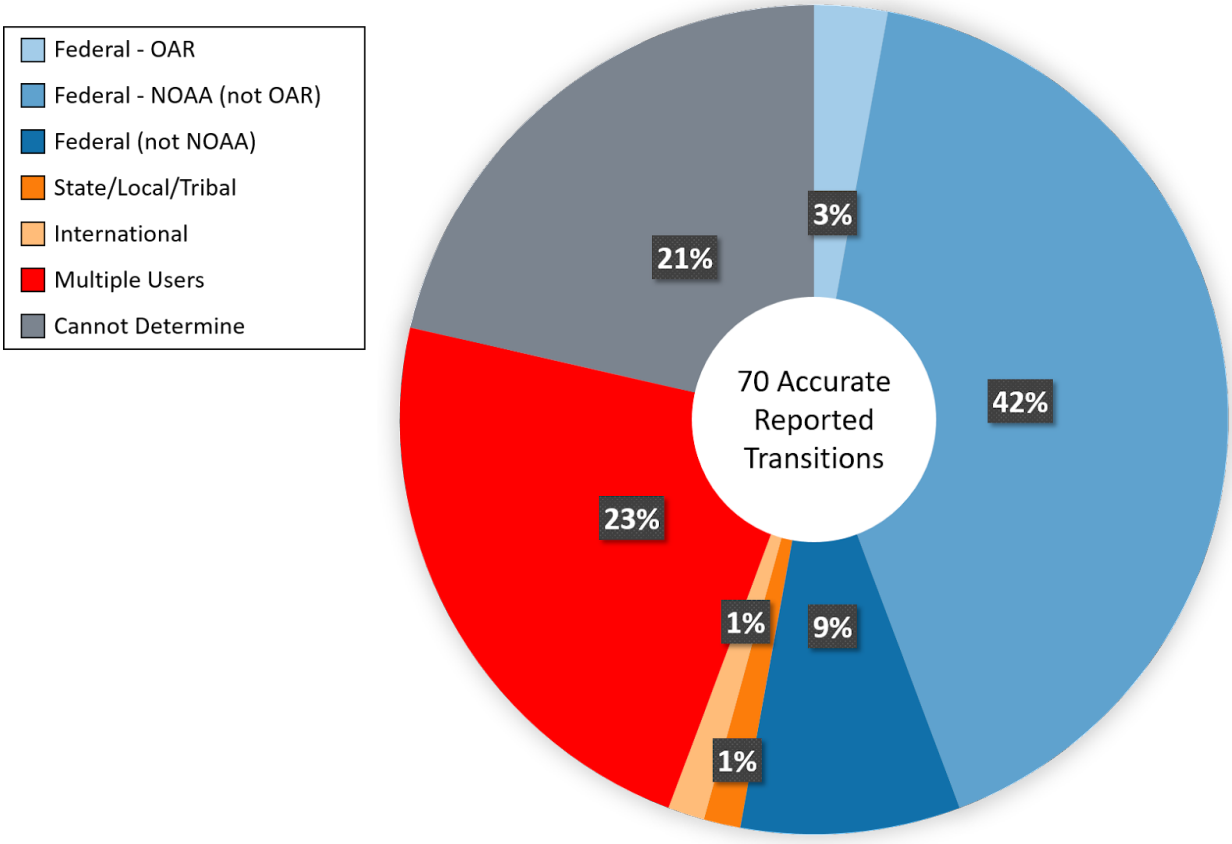

Figure 7. FY19 OAR transition recipients. This figure categorizes the solo defined end user of the 70 accurately reported transitions. Transitions that have more than one recipient are categorized in "Multiple Users". Transitions can occur within an agency and OAR may transition products to itself or to other parts of NOAA. The highest proportion of transitions in FY19 were transitioned back to NOAA or other parts of the federal government. Transitions that reported multiple recipients were categorized into multiple users.

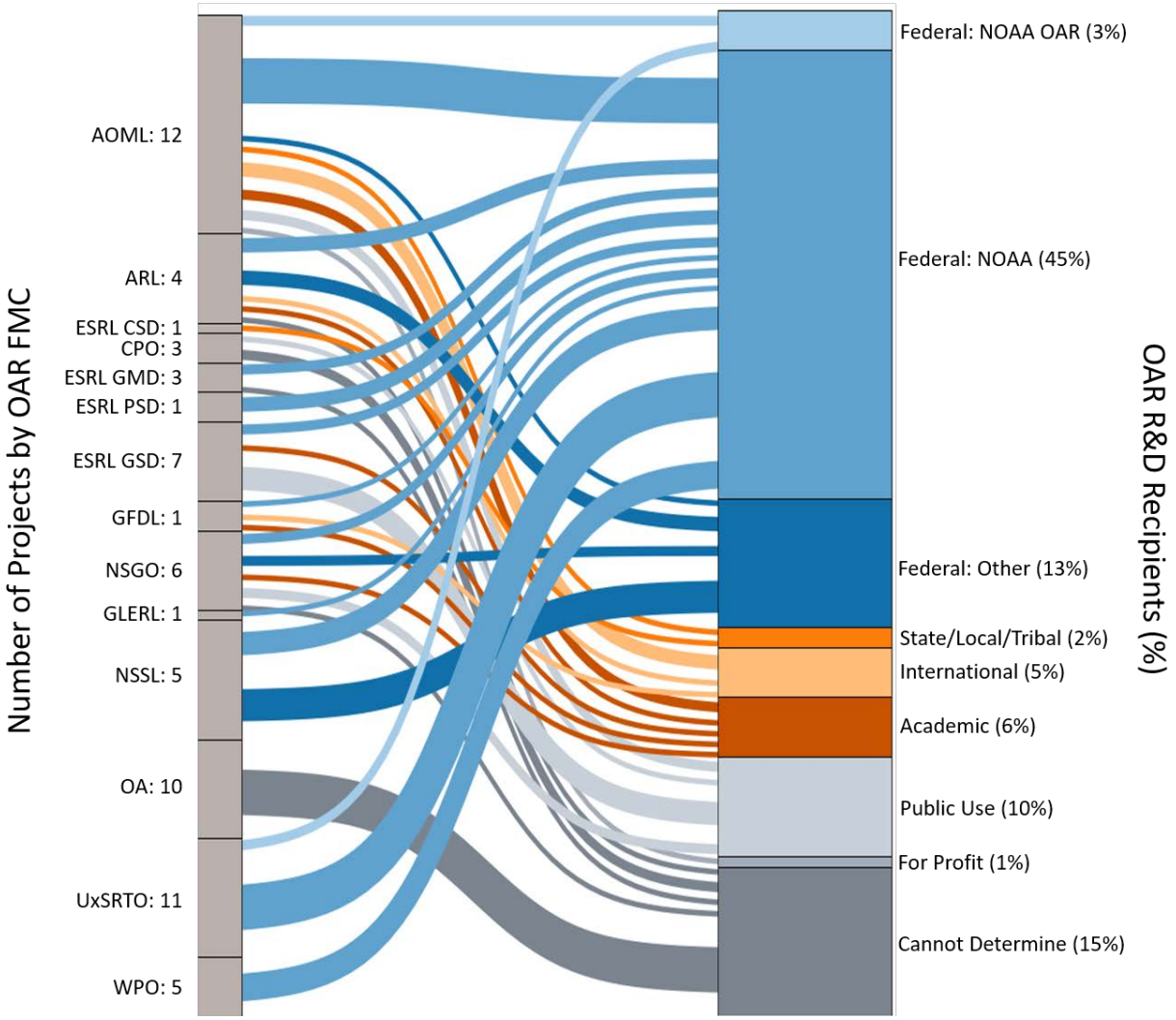

Figure 8. FY19 OAR transitions to their recipients by FMCs. This figure describes all the defined end users that each OAR FMC served with transitions. Note that some transitions served more than one recipient.

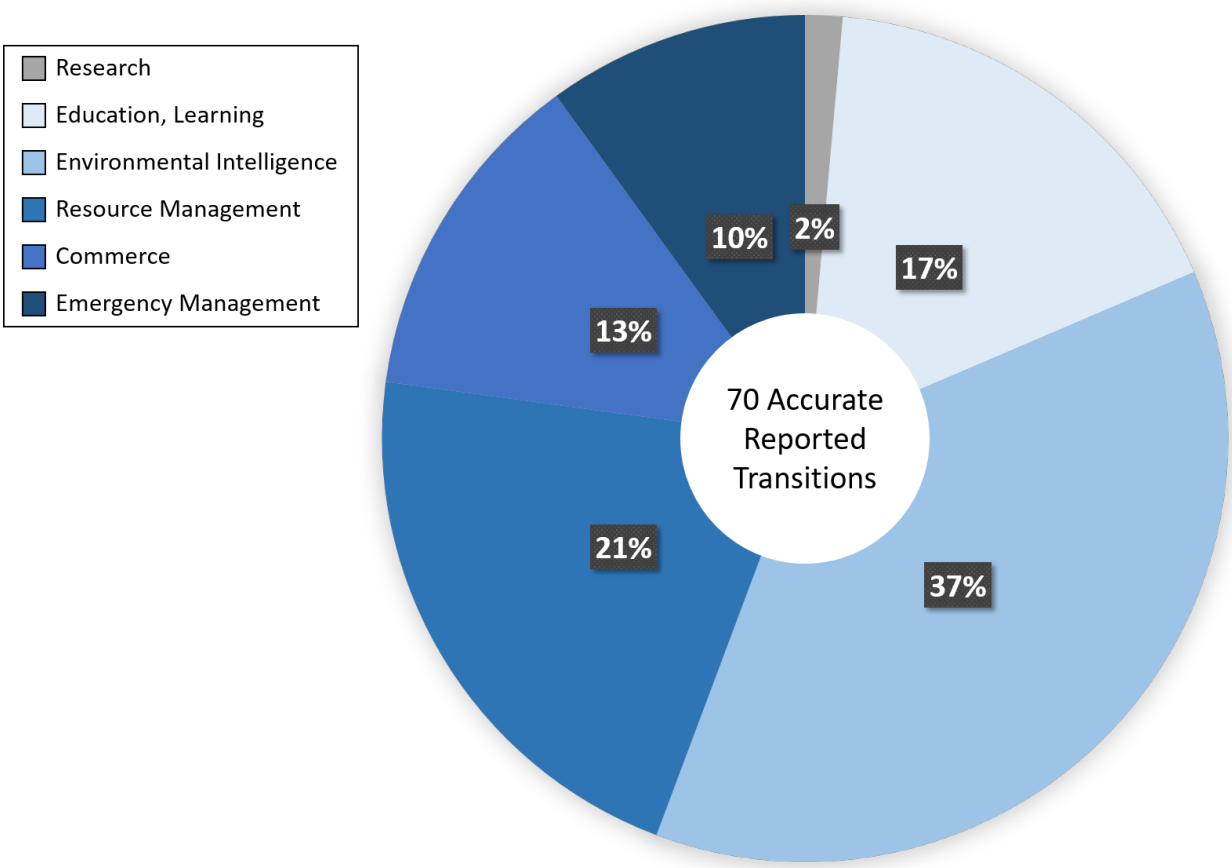

Figure 9. FY19 OAR R&D Applications. The 70 accurately reported transitions were also characterized by application type. In previous years, research was not considered an application of transition however this was the appropriate application for some specific transitions. The vast majority of transitions involved improving environmental intelligence.

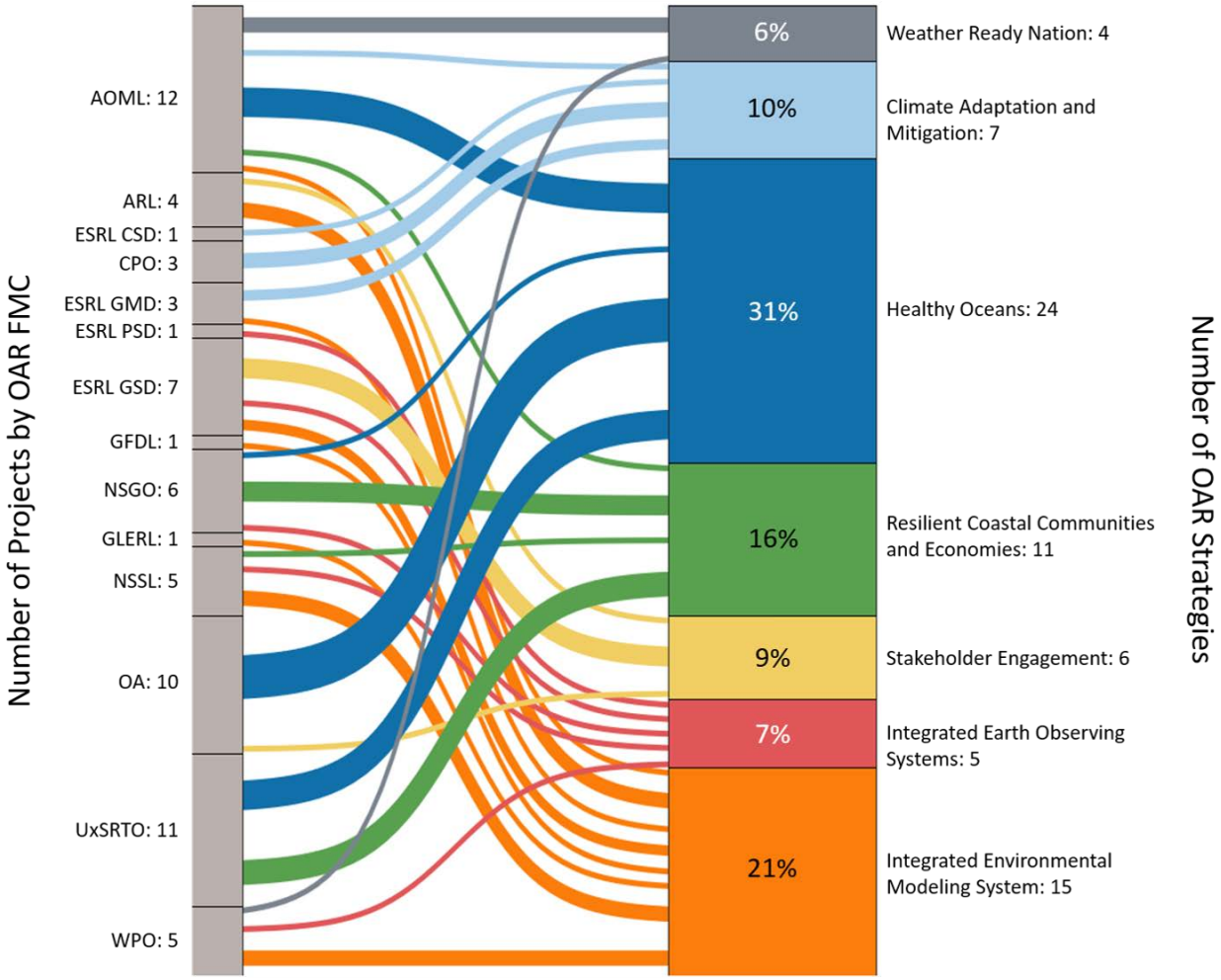

Figure 10. FY19 OAR transitions to their OAR strategies by FMCs. The 70 accurately reported transitions were categorized into one of the OAR strategic goals. OAR transitions support all of NOAA's mission areas with Healthy Oceans as the most prominent strategy served in FY19.

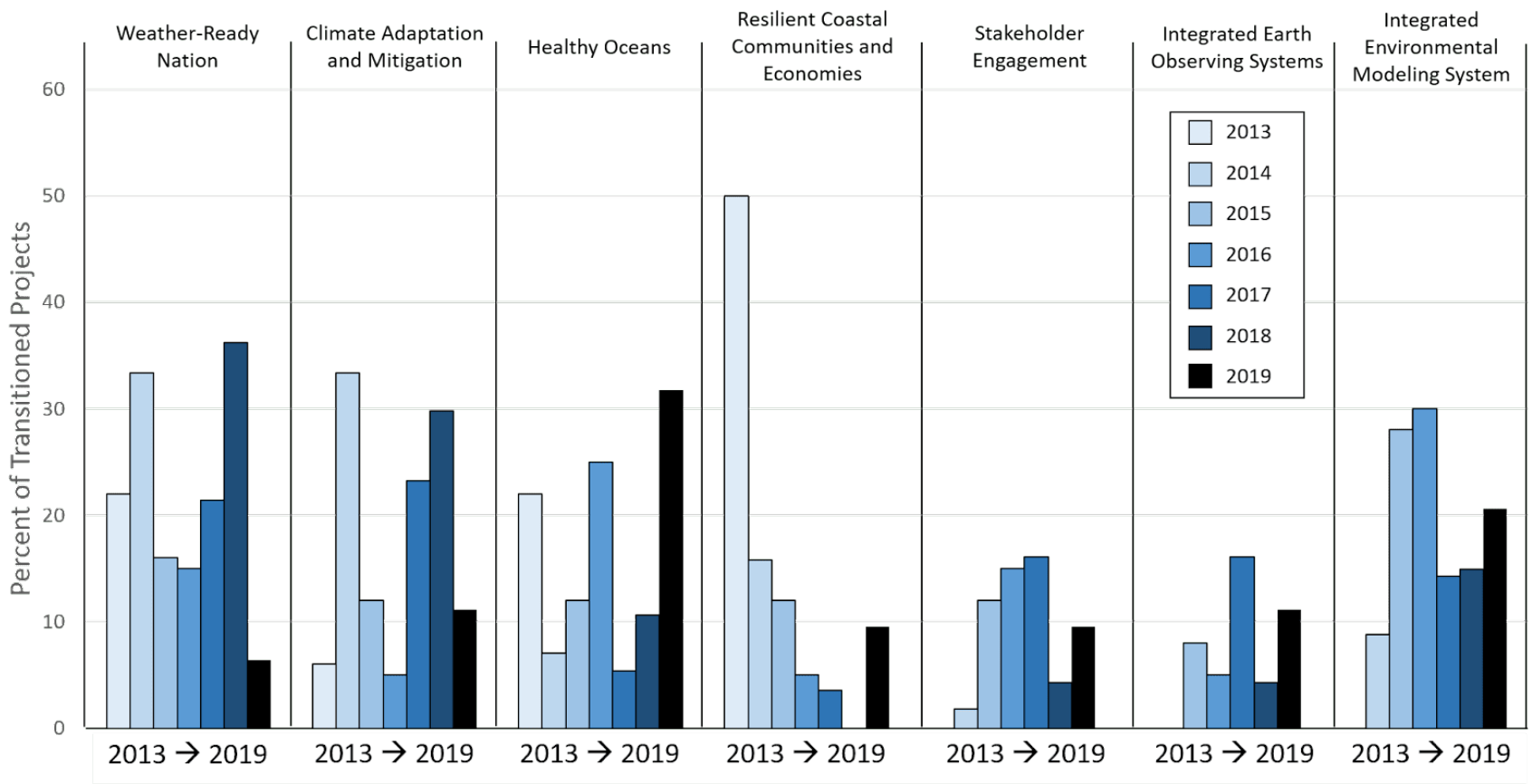

Figure 11. OAR transitions to their OAR strategies from FY13-FY19. All OAR strategies were met between 2013 and 2019. Even though there are differences in the amount of OAR transitions in each OAR strategy per year, no specific strategy was favored during this span of time.

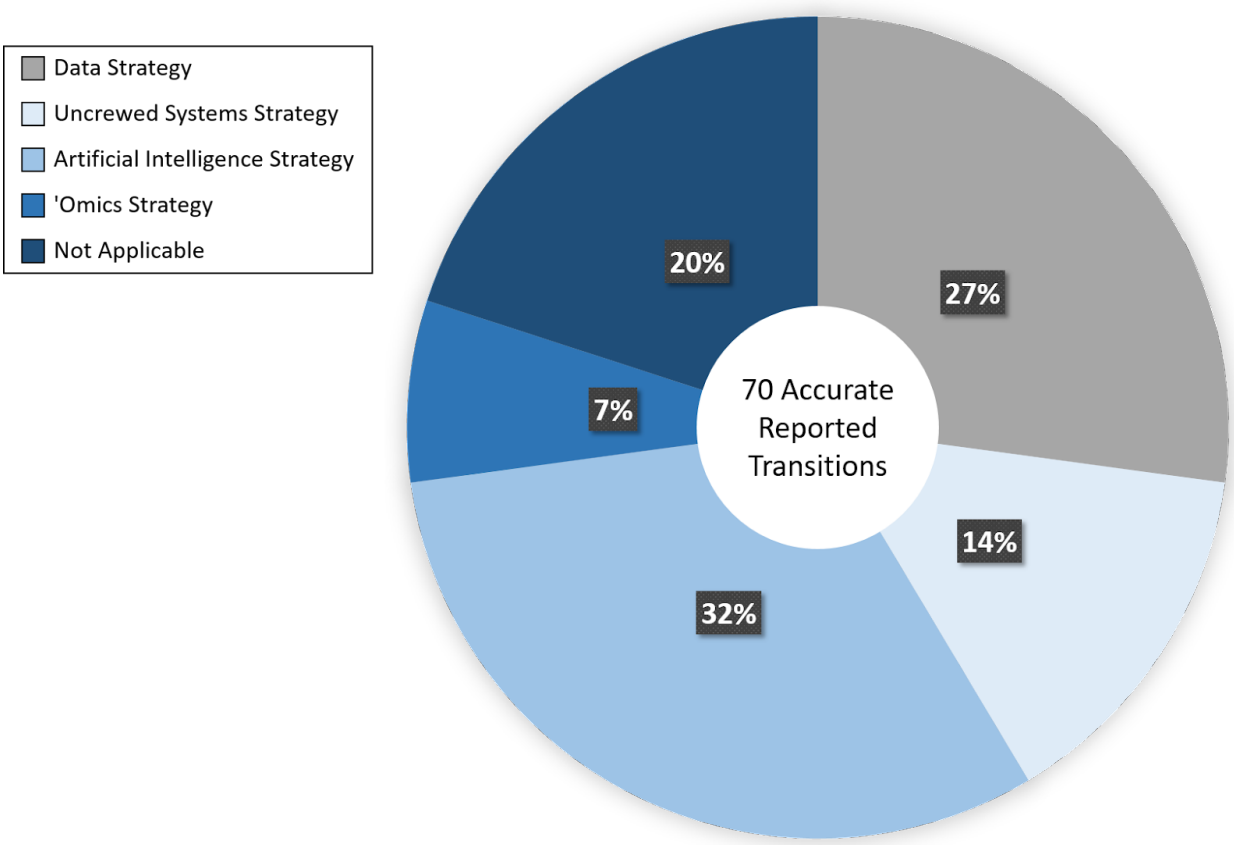

Figure 12. FY19 OAR R&D to Science & Technology Focus Areas. The 70 accurately reported transitions were categorized into one of the Science & Technology Focus Areas that NOAA leadership recently identified. In FY19, OAR transitions support four of the six focus areas, with artificial intelligence strategy as the most prominent.

Appendix A: List of Acronyms

Abbreviation	Description
AOML	Atlantic Oceanographic and Meteorological Laboratory
AOP	Annual Operating Plan
ARL	Air Resources Laboratory
CPO	Climate Program Office
ESRL CSD	Earth Systems Research Laboratory Chemical Sciences Division
ESRL GMD	Earth Systems Research Laboratory Global Modeling Division
ESRL GSD	Earth Systems Research Laboratory Global Systems Division
ESRL PSD	Earth Systems Research Laboratory Physical Science Division
FMC	Financial Management Center
GFDL	Geophysical Fluid Dynamics Laboratory
GLERL	Great Lakes Environmental Research Laboratory
NAO	NOAA Administrative Order
NESDIS	National Environmental Satellite, Data, and Information Service
NRDD	NOAA Research and Development Database
NSGO	National Sea Grant Office
NSSL	National Severe Storms Laboratory
NWS	National Weather Service
OA	Ocean Acidification Program
OAR	Oceanic and Atmospheric Research
OER	Office of Exploration and Research
PMEL	Pacific Marine Environmental Laboratory
R&D	Research and Development
R2A	Research to Applications
R2C	Research to Commercialization
R2O	Research to Operations
R2U	Research to Other Uses
R2X	Research to Operations, Applications, Commercialization or Other uses
RL	Readiness Level
S&T	NOAA Science and Technology
UxSRTO	Uncrewed Systems Research Transition Office
WPO	Weather Program Office

Appendix B: NAO 216-105B

NOAA FORM 58-5 (4-04)

	National Oceanic and Atmospheric Administration	NOAA Administrative Order 216-105B	
	NOAA ADMINISTRATIVE ORDER SERIES	DATE OF ISSUANCE 10/17/2016	EFFECTIVE DATE 10/17/2016
	SUBJECT POLICY ON RESEARCH AND DEVELOPMENT TRANSITIONS		

SECTION 1. PURPOSE AND SCOPE.

.01 The National Oceanic and Atmospheric Administration (NOAA) is a science-based service agency. NOAA's ability to meet its mission through the delivery of continually improved products and services relies on the conversion of the best available research and development (R&D) endeavors into operation and application products, commercialization, and other uses. NOAA therefore requires an integrated transition enterprise linking research, development, demonstration, and deployment that is efficient and effective in identifying and using significant new R&D products to meet NOAA's mission needs.

.02 This Order establishes the process for identifying, transitioning, and coordinating R&D output to operations, applications, commercialization, and other uses. This Order outlines the roles and responsibilities of various officials, including Line Office Transition Managers (LOTMs), associated with the transition of R&D. Additionally, this Order identifies those entities with the authority to implement this policy and those who are accountable for transitioning R&D.

.03 This Order applies to all NOAA funded R&D activities, including those conducted by non-NOAA entities.

.04 This Order defines the transition of R&D to any operation, application, commercialization, or other use, and includes products such as 24 hours/7days weather forecasts (typically referred to as research to operations), information products used in resource management (research to application), commercially-available sensors (research to commercialization), or government policies, regulations, synthesis of research, public education and outreach (research to other uses).

.05 This Order does not replace any directive, policy, statute, or other guidance that applies to the prosecution of patents by NOAA or its employees for inventions made in the course of research, the licensing of government owned inventions in the custody of NOAA, or Cooperative Research and Development Agreements and Small Business Innovative Research

awards. Such activities are addressed by NAO 201-103: Cooperative Research and Development and Invention Licensing Agreements Under the Federal Technology Transfer Act of 1986 (Public Law 99-502) and other applicable laws, regulations, and related policies. However, this NAO does apply to the identification of potential or realized uses of NOAA's R&D.

.06 Transition projects for which funding or R&D originate outside of NOAA are included in this policy, at the discretion of the respective LOTM.

.07 This Order recognizes that transitions can be either incremental improvements to existing products or applications, or entirely new products or applications.

SECTION 2. DEFINITIONS.

.01 **Application:** The use of NOAA R&D output as a system, process, product, service, or tool. Applications in NOAA include information products, assessments, and tools used in decision-making and resource management.

.02 **Commercialization:** The process of introducing a NOAA product or technology (e.g., invention) into the commercial market, including licensing.

.03 **Construction Projects:** The development, construction, or installation of equipment/asset that is not real property; or the development or modification to software, which will be used internally. The project must equal $200,000 or more; the service life is estimated to be 2 years or more; the project will provide a long-term future economic benefit to the NOAA organization that maintains or obtains control; and it is not intended for sale.

.04 **Demonstration:** Activities that are part of R&D and are intended to prove or to test whether a technology or method does, in fact, work as expected.

.05 **Deployment:** The sustained operation, maintenance, and use of the product of R&D.

.06 **Development:** The systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, that is directed to producing new products or processes, or to improving existing products or processes (OECD, 2015).

.07 **Line Office Transition Manager (LOTM):** An individual appointed by each Assistant Administrator (AA) and the Director of the Office of Marine and Aviation Operations (OMAO), who is responsible for managing the Line Office (LO) transition portfolio (collection of transition projects).

.08 **NOAA Invention:** A new, useful process, machine, manufacture, or composition of matter, or any new and useful improvement to a process, machine, manufacture, or composition of matter, developed by NOAA.

.09 **Operations:** Sustained, systematic, reliable, and robust mission activities with an institutional commitment to deliver specified products and services. Examples of operations in NOAA include weather and climate forecast models run on a routine basis to provide forecast guidance or seasonal outlooks, stock assessments conducted to determine changes in the abundance of fishery stocks, and sustained observations for public services and for Earth-System research in the public interest (NSTC 2014).

.10 **Proving Ground:** A framework for NOAA to conduct testing of advanced operations, services, and science and technology capabilities that address the needs of both internal and external users. Successful testing demonstrates readiness to implement into operations. Capabilities to be tested in operational proving grounds have already passed developmental testing. Such capabilities include advanced observing systems, better use of data in forecasts, improved forecast model, and applications for improved services and information with demonstrated economic/public safety benefits.

.11 **Readiness Levels (RLs):** A systematic project metric/measurement system that supports assessments of the maturity of R&D projects from research to operation, application, commercial product or service, or other use and allows the consistent comparison of maturity between different types of R&D projects. (Note: NOAA RL's are similar to Technology Readiness Levels developed by NASA (Mankins, 1995) and embody the same concept for quantifying the maturity of research). A project achieves a readiness level once it has accomplished all elements described within a readiness level. A program may include projects at different RLs depending on the goals of each project. Inventions may be generated at any RL. The nine readiness levels are as follows:

a. RL 1: Basic research, experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Basic research can be oriented or directed towards some broad fields of general interest, with the explicit goal of a range of future applications (OECD, 2015).

b. RL 2: Applied research, original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective. Applied research is undertaken either to determine possible uses for the findings of basic research, or to determine new methods or ways of achieving specific and predetermined objectives (OECD, 2015).

c. RL 3: Proof-of-concept for system, process, product, service, or tool; this can be considered an early phase of experimental development; feasibility studies may be included.

d. RL 4: Successful evaluation of system, subsystem, process, product, service, or tool in a laboratory or other experimental environment; this can be considered an intermediate phase of development.

e. RL 5: Successful evaluation of system, subsystem process, product, service, or tool in relevant environment through testing and prototyping; this can be considered the final stage of development before demonstration begins.

f. RL 6: Demonstration of a prototype system, subsystem, process, product, service, or tool in relevant or test environment (potential demonstrated).

g. RL 7: Prototype system, process, product, service or tool demonstrated in an operational or other relevant environment (functionality demonstrated in near-real world environment; subsystem components fully integrated into system).

h. RL 8: Finalized system, process, product, service or tool tested, and shown to operate or function as expected within user's environment; user training and documentation completed; operator or user approval given.

i. RL 9: System, process, product, service or tool deployed and used routinely.

.12 **Research:** Research can be classified as basic research or applied research.

a. Basic Research: Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Basic research can be oriented or directed towards some broad fields of general interest, with the explicit goal of a range of future applications (OECD, 2015).

b. Applied Research: Applied research is the original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective. Applied research is undertaken either to determine possible uses for the findings of basic research or to determine new methods or ways of achieving specific and predetermined objectives (OECD, 2015).

.13 **Testbed:** A NOAA testbed is a working relationship for developmental testing in a quasi-operational framework among researchers and operational scientists/experts (such as measurement specialists, forecasters, IT specialists) including partners in academia, the private sector, and government agencies, aimed at solving operational problems or enhancing operations, in the context of user needs. A successful testbed involves physical assets as well as substantial commitments and partnerships.

.14 **Transition:** The transfer of an R&D output to a capability ready for an operation, application, commercial product or service, or other use.

.15 **Transition Plan:** A document that represents an agreement between clearly identified researchers and potential recipients, organizations, or other users of the product resulting from the transition of an R&D output.

.16 **Transition Project:** A collective set of activities necessary to transfer R&D output to a capability ready for an operation, application, commercial product, or service, or other use (RL 9).

.17 **Transition Project Lead(s):** Individual(s) responsible and accountable for ensuring that the transition project is planned, programmed, budgeted, and executed per the Transition Plan.

SECTION 3. POLICY.

.01 To meet mission needs, NOAA will optimize the timely and efficient use of R&D, including but not limited to that conducted by and funded by NOAA. To fulfill this goal, NOAA shall maintain:

a. A mission-oriented enterprise capable of quickly identifying and applying demonstrated R&D outputs to provide new and improved products, services, or more efficient operations while continuing to maintain reliable, cost-effective services for users;

b. An R&D enterprise that routinely provides proven R&D outputs to serve NOAA's mission while adapting its portfolio to address new research frontiers; and,

c. Project management, planning, and oversight processes that include routine identification of new opportunities/needs for research, development of Transition Plans, status reporting, and test and evaluation procedures.

.02 Transition Plans are essential for describing and facilitating the transition of R&D to potential end use, and represent an agreement between researchers, operators and/or users that describes a feasible transition pathway and potential Concept of Operations (CONOPS).

.03 Transition Plans should be developed as early as possible to reflect the relationship between R&D and NOAA's mission and the commitment by the entities involved to the potential transition of R&D.

.04 Transition Plans are recommended for projects that seek to progress beyond RL 4.

.05 The determination of whether a transition project shall have a written transition plan is at the discretion of the AA(s), or their designees, from the affected LO(s). In making this determination, factors that may be considered include but are not limited to the following:

a. The risks associated with, and the sensitivity of, the transition;

b. The organizations involved in the transition, and their history of implementing transition activities together;

c. The duration of the transition activities;

d. The cost of transition activities;

e. Potential societal impact; and

f. The complexity of the transition, including whether the project is novel or a routine update to existing operations or applications.

For transitions that involve multiple LOs, if any of the AAs or their designees determine that a written transition plan is justified then one shall be developed.

.06 Transition Plans shall incorporate the following:

a. A description of the activities necessary to transfer an R&D output;

b. Clearly defined goals for the new/revised product or service, milestones, schedule, and transition success/acceptance criteria;

c. To the best estimate, the amount and source of funds needed to cover the costs associated with the transition, as well as the cost of future operations as necessary, including relevant requirements for equipment, upgrades, staff training, and maintenance of redundant application capabilities during the transition period;

d. A clear designation of potential researcher(s), operational entity(ies) and/or end user(s), and a description of when they will engage and as often as necessary to ensure all parties are fully invested in the R&D transition process;

e. A mechanism for providing clear communication among all participants concerning the transition, including routine engagement of the management chain in the affected LO(s) and partner organizations; and

f. A mechanism for updating the plan as necessary to reflect changes in the plan warranted by results of the transition process or unforeseen events (e.g., updated budgets).

.07 Transition Plans shall be approved by the AA(s), or their designees, from the affected LO(s).

.08 Transition Planning integrated into Agency Planning: LOTMs shall strive to include transition projects within their portfolio as appropriate into NOAA planning documents, including NOAA strategic plans and LO Annual Operating Plans.

.09 Transition Budgeting integrated into Agency Budgeting: LOTMs shall work towards ensuring that the resources needed to transition R&D outputs to sustainable applications,

operations, construction projects, commercialization or other uses are appropriately addressed and included in the Line Office submissions in the appropriate NOAA budget processes.

.10 Evaluation: All Transition Projects shall be reviewed on a periodic basis using the evaluation criteria identified in respective Transition Plans to ensure progress towards readiness levels, goals and milestones.

.11 Reporting: LOTMs will work with Transition Project Leads to report on execution status of transition projects on a regular basis.

.12 This Order follows the guidelines established in NOAA Administrative Order 216-115A, Research and Development in NOAA.

.13 This Order supports the policies and procedures contained in the Paperwork Reduction Act, the Government Paperwork Elimination Act, the Federal Technology Transfer Act, the Bayh-Dole Act, Office of Management and Budget (OMB) Circular No. A-130, Management of Federal Information Resources, the NOAA Information Quality Guidelines, and other applicable relevant laws, regulations, and policies. These authoritative requirements apply government resources to activities in support of the agency's mission, outline procedures to ensure and maximize the quality, utility, and integrity of resultant information, and seek to maximize the benefits of resultant information and intellectual property to society.

.14 NOAA shall be cognizant of and observe the valid rights of patent holders and owners of other intellectual property.

.15 NOAA Invention Disclosure: Prior to any public disclosure (including but not limited to presentations at a public meeting, or publications on a public-facing webpage or in scientific literature), a NOAA invention shall be reported to the NOAA Technology Partnerships Office (TPO) for:

a. Rights determination;

b. Evaluation of patentability and commercial potential; and

c. Inclusion in the NOAA technology and innovation portfolio.

SECTION 4. GOVERNANCE AND RESPONSIBILITIES.

.01 The Under Secretary of Commerce for Oceans and Atmosphere (NOAA Administrator), the Deputy Under Secretary/Operations, and the NOAA Chief Scientist shall provide top management oversight for implementation of this policy, and the development and implementation of associated procedures.

.02 The AAs, the OMAO Director and appropriate NOAA Staff Offices (SOs) support the implementation of this policy through their roles in the NOAA Organizational Handbook.

.03 LO AAs and the Director, OMAO are responsible for the following:

a. Promoting the goals and implementing the requirements of this policy;

b. Appointing LOTMs;

c. Determining, or delegating determination of, whether specific transition projects require written transition plans;

d. When appropriate, approving, or delegating approval of, Transition Plans;

e. Ensuring that Transition Teams are appropriately resourced to carry out their responsibilities;

f. Providing or delegating oversight for all transition projects in their LO;

g. Ensuring LO Transition Project reviews are conducted as appropriate; and

h. Reporting on the execution status of transition projects per instructions provided by the Deputy Under Secretary for Oceans and Atmosphere.

.04 LOTMs include representatives of the LO AAs and the Director, OMAO. The LOTMs are responsible for the following:

a. Collectively monitoring the NOAA transition portfolio (collection of transition projects);

b. Incorporating applicable LO transition projects into NOAA's planning, budget, execution, and evaluation processes;

c. Tracking and providing timely reports to the NOAA Research Council on the status of the portfolio (collection of transition projects);

d. Ensuring the development of appropriate Transition Plans; and

e. Evaluating transition projects with respect to Transition Plans.

The collective LOTMs form a standing committee of the NOAA Research Council. As such, they are expected to report to the Council at least annually on the status of NOAA's transition activities and:

f. Inform the Council on issues of concern related to the transition of research; and

g. Respond to guidance and direction from the Council.

.05 The TPO Director is responsible for:

a. Providing the LOTM committee with updates on TPO activities;

b. Maintaining a database of transitions occurring under TPO purview;

c. Informing the LOTMs of transition opportunities to NOAA application; and

d. Informing the LOTMs of potential intellectual property issues pertaining to specific technology projects.

.06 Transition Project Leads are responsible for managing the transition projects and all associated activities. For transition projects that include construction projects (as defined in 2.03), Transition Project Leads are responsible for providing planning and budgeting documents to a designated Line Office Construction Work-In-Progress Project Manager, who will follow the process and procedures for constructed projects detailed in the NOAA CWIP Policy (http://www.corporateservices.noaa.gov/finance/docs/CWIP/CWIPPolicy--May2016FINAL.pdf).

.07 Transition Teams should include representatives from both the research output and operations or end-user communities. Transition Teams are responsible for the following:

a. Coordinating transition activities; and

b. Identifying, reporting, and responding to significant deviations in the execution of the Transition Plan.

.08 The NOAA Research Council is responsible for the following:

a. Overseeing the LOTM committee;

b. Providing guidance and advice to the NOAA Chief Scientist as pertains to research transition policy, process and practice; and

c. Establishing or overseeing the establishment of policies and processes to foster effective transitions.

.09 Other applicable Councils, such as the NOAA Observing Systems Council and the NOAA Ocean and Coastal Council, are responsible for participating in the NOAA's planning, budget, execution, and evaluation processes and providing comments regarding the identification and readiness of projects for transition and the relative priority of these projects.

SECTION 5. REFERENCES.

.01 Working through the LOTM Committee, the Research Council will develop and disseminate

written procedures, plans, and reports as necessary to implement this Order, including but not limited to:

a. Procedural Handbook covering, but not limited to, the following topics:

   i. Use and interpretation of RLs in NOAA; and

   ii. Guidance for developing effective Transition Plans.

.02 Existing documents referenced in this policy are as follows:

a. Mankins, John C. (6 April 1995). "Technology Readiness Levels: A White Paper" (PDF). NASA, Office of Space Access and Technology, Advanced Concepts Office. http://www.hq.nasa.gov/office/codeq/tr l/trl.pdf.

b. NSTC (2014). "National Plan for Civil Earth Observations", https://www.whitehouse.gov/site/default/files/microsites/ostp/NSTC/national_plan_for_civil_earth_observat ions_-_july_2014. pdf

c. NOAA Invention Disclosure and Rights Questionnaire Instructions, http://www.corporateservices.noaa.gov/ames/administrative_orders/chapter_201/201-103-appendix-b.html

d. NOAA Invention Disclosure and Rights Questionnaire http://ocio.os.doc.gov/s/groups/public/@doc/@os/@ocio/@oitpp/documents/content/dev01_002431.pdf

e. OECD (2015), *Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development*, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264239012-en

SECTION 6. EFFECT ON OTHER ISSUANCES.

.01 This Order supersedes NOAA Administrative Order (NAO) 216-105A, Policy on Research and Development Transitions issued December 3, 2015.

.02 The Under Secretary of Commerce for Oceans and Atmosphere signs because there is no delegation of authority for this NAO.

An electronic copy of this Order will be posted in place of the superseded Order on the NOAA Office of the Chief Administrative Officer website under the NOAA Administrative Issuances Section. http://www.corporateservices.noaa.gov/~ocao/index.html

Under Secretary of Commerce
for Oceans and Atmosphere

Office of Primary Interest:
Office of Oceanic and Atmospheric Research (OAR)

NOAA Administrative Order (NAO) 216-105B:

Policy on Research and Development Transitions

Procedural Handbook

Table of Contents

NAO 216-105B Procedural Handbook: Policy on Research and Development Transitions

Issuing Office: National Oceanic and Atmospheric Administration (NOAA) Office of the Chief Scientist

Release Date: March 21, 2017

1. **Explanation of Material Transmitted:** This Handbook establishes procedures for the planning, monitoring, implementation, evaluation, and reporting of Transition of Research and Development in support of NAO 216-105B.
2. **Filing Instructions:**
    a. Remove: NAO 216-105, Procedural Handbook, dated: 04/28/2014
    b. Insert: NAO 216-105B, Procedural Handbook, dated: 03/21/2017
3. **Additional Information**:
    a. For information on the content of the Handbook, contact the issuing office listed above.
    b. To access the Handbook chapters and appendices online, follow links available from this URL: http://www.corporateservices.noaa.gov/ames/administrative_orders/chapter_216/216-105B.html

Chapter 1 – Purpose and Scope of the NAO for Research and Development Transitions (NAO 216-105B)

A. Purpose

This Handbook supports the NAO on Research and Development (R&D) Transitions (NAO 216-105B[1]). Chapters 2-4 of this Handbook are intended to provide additional guidance for the corresponding sections of the NAO.

This Handbook is established in accordance with NAO 200-3[2] which specifies that NOAA handbooks and manuals containing policy or procedures be elements of the NAO series, providing in-depth coverage of those subjects so complex or extensive as to benefit from coverage in the form of a handbook or manual, and shall have the same force and effect as that NAO.

The use of *Italics* throughout this Handbook indicates language quoted from NAO 216-105B.

B. Policy Background and Scope

The transition of R&D into operations[3], applications[4], commercial product or service, and other regular use (i.e., deployment) is a key process for NOAA as a science-based services and stewardship agency. Efficient conversion of the best available research and development into operations, applications, commercialization and other uses is critical to our mission (Dorman 1999; NRC 2000; NRC 2003; NOAA SAB 2004). NAO 216-105B establishes the process for identifying and transitioning R&D to operations, applications, commercial product or service, and other regular use. The policy outlines the roles and responsibilities of various officials, including Line Office Transition Managers (LOTMs), associated with R&D transition. Additionally, the policy identifies those entities with the authority to implement this policy and those who are accountable for R&D transitions.

NAO 216-105B applies to NOAA R&D activities, including those funded by NOAA but conducted by non-NOAA entities such as academic institutions and consortia. The standard for which R&D activities are subject to the NAO is left to the discretion of the respective Assistant Administrator (AA) or their delegate. The policy also recognizes that transitions can be either incremental improvements to existing products or applications or entirely new products or applications.

C. References

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[1] NAO 216-105B: http://www.corporateservices.noaa.gov/ames/administrative_orders/chapter_216/216-105B.html
[2] NAO 200-3 (*The NOAA Administrative Order Series*): http://www.corporateservices.noaa.gov/ames/administrative_orders/chapter_200/200-3.html
[3] Operations: Sustained, systematic, reliable, and robust mission activities with an institutional commitment to deliver specified products and services.
[4] Applications: The use of NOAA R&D output as a system, process, product, service or tool. Applications in NOAA include information products, assessments and tools used in decision-making and resource management.

Please see Appendix A: References for NAO Procedural Handbook (alphabetical order)

D. **Abbreviations**

Please refer to Appendix B: Abbreviations Used in NAO Procedural Handbook

Chapter 2 – Key Terms and Understanding Transition

A. Purpose

This Chapter expands on the brief definitions provided in Section 2 of the NAO. Not all the terms and definitions from the NAO are included here, but the concepts that might benefit most from further discussion are presented in this Chapter.

B. Core Concept of R&D Transition

Transition of R&D[5] is *the transfer of an R&D output to an operation, application, commercial product or service, or other use*. While it varies from agency to agency or sector to sector, transition requires the evolution of a research project through a clearly defined series of stages. While these stages are set in serial fashion, transition may be achieved without completing all the stages.

C. Understanding Readiness Levels

Readiness levels (RLs) are a systematic project metric/measurement system that supports assessments of the maturity of R&D projects from research to operation, application, commercial product or service, or other use and allows the consistent comparison of maturity between different types of R&D projects.

The concept of Technology Readiness Levels was developed by NASA (Mankins, 1995[6]) to manage technology development and risk. NAO 216-105B adapts this concept to NOAA. The NAO provides simple but minimalist definitions of each of nine Readiness Levels that describe the progression of an idea from the research stage to the point where the idea has become a product or tool in regular use. Despite some recent suggestions to define a tenth RL (e.g., Straub, 2015), the NOAA system is constrained to the widely-applied nine RLs described below. The word "technology" was dropped since much of what NOAA produces does not meet the definition of technology.

The purpose of creating a single scale for all of NOAA is to encourage cross-disciplinary understanding of the challenges involved in developing an idea into something that serves a NOAA mission need. With appropriate flexibility in interpretation, it should be possible to successfully classify all relevant R&D projects across the NOAA enterprise by Readiness Level.

Many programs in NOAA run projects at a variety of Readiness Levels and a clear distinction between Readiness Levels and their applicability to each project may be difficult to identify. Program managers are therefore encouraged to use established Line Office, or program standards and benchmarks and engage in dialog with other program managers and their LOTM to define any questionable project Readiness Levels.

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[5] Note: In the NOAA context, R&D means Research and/or Development since not all development at NOAA begins with Research (e.g., new work being done on a more advanced system).

[6] Mankins (1995): http://www.hq.nasa.gov/office/codeq/trl/trl.pdf

At a given project level, the RL is defined at the lowest RL of any of the system components. For example, a project combining two commercial off-the-shelf (COTS) components (by definition, RL 9) with software for a new application that is at RL 4 is considered RL 4 as a project or system.

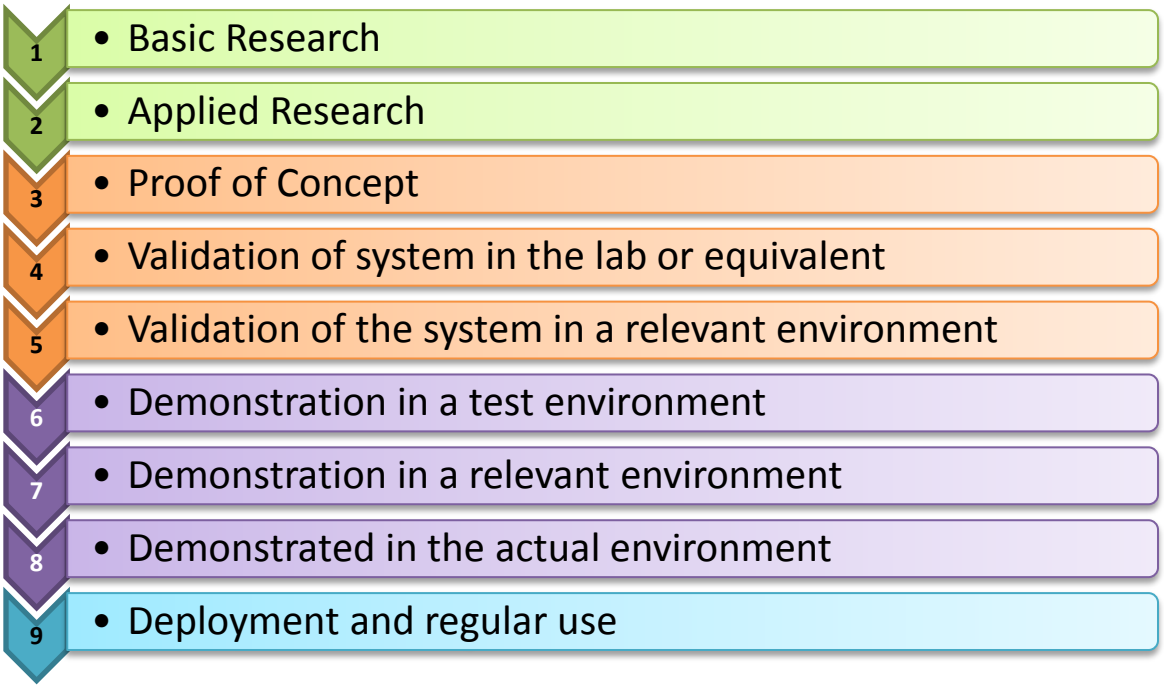

Figure 1. Summary of Readiness Levels (RLs) highlighting the key step for completion of each RL. Colors correspond to the different phases for transition of R&D and RLs are ordered as they would be in the transition funnel (research at the top and deployment at the bottom).

RL 1: Basic research: systematic study directed toward fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind. Basic research, however, may include activities with broad applications in mind. (See Appendix C for further details)

RL 2: Applied research: systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met; invention and concept formulation.

If new research is directly addressing a specific NOAA service or stewardship mission requirement, it is RL 2 by definition that it is research applied toward a specific need.

RL 3: Proof-of-concept for system, process, product, service or tool; this can be considered an early phase of development; feasibility studies may be included.

Beginning at RL 3, there should be increasing involvement of the deploying unit, receiving unit, or end user to aid in the focusing of the research on a mission application. The earliest version of a concept of operations (CONOPS) should be developed no later than RL 3. Depending on the scope of work and the amount of resources utilized (i.e., personnel, funding, equipment and facilities), the CONOPS could vary from a short addendum to a larger program research plan.

RL 4: Validation of system, subsystem, process, product, service or tool in laboratory or other experimental environment; this can be considered an intermediate phase of development.

A viable business case should be in place at RL 4 outlining projected costs and other organizational requirements to get from RL 4 to RL 9. The business case needs to also include a best estimate for total costs in operations or application, including the operations and maintenance "tail" (i.e., total life cycle costs). Depending on the scope of work and the amount of resources utilized (i.e., personnel, funding, equipment and facilities), the business case could vary from a short addendum to a larger program resource requirements plan.

If required by the relevant AAs or their delegates, projects needing a transition plan, should not be resourced beyond RL4 without an approved transition plan in place (NAO 216-105B §3.02-3.08). It is reasonable to expect that transition plans will be proportional in scale, scope, and level of detail relative to the scale, scope, and maturity of the project. Smaller, early RL projects will logically have smaller, less developed transition plans, (if at all) in comparison with larger, more mature projects.

RL 5: Validation of system, subsystem process, product, service or tool in relevant environment through testing and prototyping; this can be considered the final stage of development before demonstration begins.

At RL 5, validation should be done on a prototype of at least medium fidelity in a relevant test environment, to show attainment of pre-defined performance specifications. For certain applications, this would include integrating the system with realistic supporting elements so the system can be tested in a simulated end-use environment.

RL 6: Demonstration of prototype system, subsystem, process, product, service or tool in relevant or test environment (potential demonstrated).

At this stage, a high-fidelity system, component, tool, or service is demonstrated to work in a test environment that includes critical components of the end-use environment. RL 6 is a level where it often becomes necessary to engage with a testbed, research platform (e.g., research vessel), or other demonstration facility to have adequate access to critical components of the end-use environment.

RL 7: Prototype system, process, product, service or tool demonstrated in an operational or other relevant environment (functionality demonstrated in near-real world environment; subsystem components fully integrated into system).

Testbeds, while not required, continue to be a valuable demonstration environment for many transition projects at RL 7, and throughout transition testing, to provide stable access to a near-real world environment. Also, at RL 7, the research and deploying units can expect to fully depend on each other's resources to achieve the milestones to mature beyond this RL.

RL 8: Finalized system, process, product, service or tool tested, and shown to operate or function as expected within user's environment; user training and documentation completed; operator or user approval given.

By RL 8, the deploying unit can expect to be investing a significant fraction, likely the majority, of the resources needed to complete the milestones to advance the transition project.

RL 9: System, process, product, service or tool deployed and used routinely.

Once the system, product, process, service, or tool is fully deployed, it has completed the process transition of R&D. However, it is important to realize that the originating research unit will likely continue to be involved (at a greatly reduced level) to continue refinements or incremental improvements throughout the total life cycle of the system, tool, or service.

Not all transition projects will need to pass through all RLs as distinct steps. Many transition projects may start at a relatively high RL (e.g., several mature components being combined in a novel way). In other cases, some transition projects may start at RL 2 or RL 3, and move as a step function to RL 8 or RL 9 without passing through any intervening RLs. This may be particularly applicable for research conducted to better inform resource management decisions or to develop regulations.

The transition funnel is used within NOAA as a visual tool for understanding the overall process of transitioning R&D.

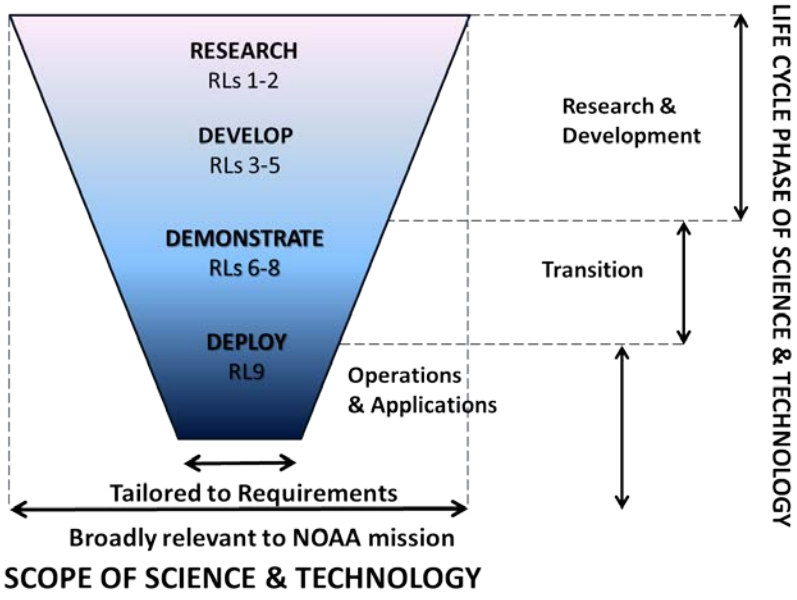

Figure 2. The NOAA transition funnel.

The transition funnel represents at the wide end the range of creative research ideas and projects that emerge in early stages of research. The narrow end reflects the limited number of those early stage research projects that will ultimately transition to deployment at RL 9. Implicit in this representation is that some research projects will fail to meet mission needs along the way towards RL 9 and will be terminated, transferred to an extramural partner, or otherwise divested.

D. Transition Project Leads and Transition Plans

1. Transition Project Leads

Transition Project Leads are the *individual(s) responsible and accountable for ensuring that the transition project is planned, programmed, budgeted, and executed per the Transition Plan*. At a minimum, on smaller transition projects, there would be one Transition Project Lead each for:

- The research and development of the system
- The deployment and regular use of the system

However, in more complicated cases, having more Transition Project Leads may be a useful management approach.

It is essential that the Transition Project Leads have sufficient authority and resources to be responsible and accountable for their portions of the transition project. Transition Project Leads will use established Line Office, or program standards and benchmarks to determine the appropriate oversight and coordinate reporting. The NOAA Technology Partnerships Office should be included as a consulting partner in all cases where a new and novel technology has been developed.

2. Transition Plans

Transition Plans are essential for describing and facilitating the transition of R&D to potential end use, and represent an agreement between researchers, operators and/or users that describes a feasible transition pathway and potential concept of operations (CONOPS). Transition Plans are recommended for projects that seek to progress beyond RL4 (NAO 216-105B §3.02-3.03; see also Ch. 2.C.RL4 in this Handbook).

Depending on the scope of work and the amount of resources utilized (i.e., personnel, funding, equipment and facilities), transition plans can vary from a list of milestones to a fully developed program plan. It is also reasonable to expect that projects that are less mature and many years from implementation may have less developed transition plans than those that are only a few years from deployment. Ultimately, each AA or their delegate can set the requirements and expectations for Transition Plans for their Line Office for the projects that require a transition plan.

A Transition Plan Should:

- Be developed once, and updated as necessary;

- Start simple, and gain complexity and detail as a project matures;
- Have complexity and level of effort proportional to the scale, risk, maturity and scope of the project;
- Be widely applicable to a range of planning or management needs;
- Be able to serve as a supporting document to articulate how a specific activity or funding (or lack of), will impact the Transition Project;
- Eventually cover all the expected activities, costs, milestones, etc. for the total life cycle (i.e., from the current RL of the Transition Project through deployment including operations and maintenance costs).

A Transition Plan Should NOT:

- Be tailored to a specific program, request for proposals (RFP), or data call;
- Be a scientific or technical proposal;
- Be an implementation or deployment plan.

At a minimum, the Transition Project Leads should review the Transition Plan on an annual basis, though semi-annual or more frequent review may be more appropriate for faster-paced or more complex Transition Projects. If there are any changes to milestones, timelines, or other aspects of the Transition Plan the respective LOTMs and Division Chiefs (or equivalents) should be consulted about whether the changes are substantial enough to require formal approvals for the updated Transition Plan. Minor changes to transition plans should only require Division Chief (or lower) level approvals for both the research and deployment units. More substantial changes in the transition plan to project milestones, costs, objectives, etc. require a proportionally greater level of approval as guided by the respective LOTMs and Line Office procedures.

A template for a Transition Plan can be found in Appendix D and the generalized process for approving Transition Plans can be found in Appendix E.

E. Additional Approvals that may be Necessary

The NAO recommends that transition projects should have an approved transition plan. However, there may be additional project specific requirements beyond a standard transition plan, including, but not limited to:

1. Testbeds and Proving Grounds

If using a testbed[7] or proving ground is part of a transition plan, a letter of support should be obtained from the testbed manager at the earliest practical time. The letter of support should indicate that the testbed manager has reviewed the project requirements, milestones, and transition plan, and that the testbed expects to be able to support the transition project in accordance with what the project requires.

2. Construction Projects

[7] http://www.testbeds.noaa.gov/

If the transition project includes construction, additional clearance will be required in accordance with guidance available from a designated Line Office Construction Work-In-Progress Project Manager, who will follow the process and procedures for constructed projects detailed in the NOAA CWIP Policy[8].

The NOAA CWIP Policy applies to "Property, Plant, and Equipment" (both real property and personal property) and "Internal Use Software Development" that

- Has an aggregate acquisition cost of $200,000 or more,
- Has an estimated service life of 2 years or more,
- Provides a long-term future economic benefit to the NOAA organization which maintains or obtains control, and
- Is not intended for sale.

3. High Performance Computing (HPC)

If a transition project is planning to make substantial demands on HPC resources, or plans to purchase new, or upgrade existing, HPC resources then Transition Project Leads and LOTMs should engage the relevant HPC management bodies within the agency for their approval as early as possible.

4. Invention Disclosure

Each new and novel technology developed should be disclosed to the NOAA Technology Partnerships Office prior to any public disclosure using the CD-240[9] invention disclosure form.

5. Sensitive or Secure Technology Approvals

All technology, software, and materials in transition projects need to be considerate of requirements to comply with DOC Export Administration Regulations (EAR)[10] and DOS International Traffic in Arms Regulations (ITAR)[11]. If a transition project involves any technology, software, or other materials subject to EAR or ITAR, that should be disclosed in the transition plan with approvals indicating that the transition plan will comply fully with those regulations.

[8] http://www.corporateservices.noaa.gov/~finance/documents/CWIPPolicy--March2017FINAL.pdf
[9] http://techpartnerships.noaa.gov/sites/orta/Documents/CD-240-2013.pdf
[10] https://www.bis.doc.gov/index.php/regulations/export-administration-regulations-ear
[11] https://www.pmddtc.state.gov/regulations_laws/itar.html

Chapter 3 – Implementing the Policy on Transition of Research and Development

A. **Purpose**

This Chapter provides details of the process of transition of R&D as it applies across NOAA's mission areas. Emphasis is placed on the essential steps in the implementation process in order to guide the transition practitioner as well as the officials responsible for evaluating transition of R&D in their program or Line Office.

B. **Planning for Transition of R&D**

Successful transition of R&D products to regular use or final deployment or implementation demands careful planning including:

- Early partnership between researchers and potential users/operators
    - The research unit requires a clear understanding of the mission need during the earliest phases of applied research (RL 2) or proof of concept (RL 3), and the deploying unit needs a good understanding of how the new research can address their mission requirements. This is accomplished best by the two organizational units working closely together at the earliest phase of the transition project, including forging clear communication of mission requirements from the deploying unit and clear communication of research potential from the research unit.
    - Where uncertainty exists in the research stage regarding the potential users/operators, a business case and transition plan should be developed as early as possible to ensure identification of the user/operator.
- Early engagement with social science and design experts
    - Recognizing that in many cases for NOAA, the ultimate end user is not the deploying unit, but rather the general public, it is important to engage with social scientists early in the R&D process to ensure that the final state is useful to the intended audience.
    - Recognizing that many applications have interactive interfaces that must be designed for ease of use by intended users.
- Developing an accurate and viable business case
    - A viable business case demonstrates that when the transition project reaches maturity, the deployment is desirable and warranted based on mission needs, and feasible and sustainable with anticipated levels of agency resources.
    - Not all research will have a viable business case for deployment. It is important to realize potential weakness in the business case very early so that changes to the transition project can be made to improve the business case for deployment.
- Incorporation of key decision points for determining progress
    - It is essential that transition projects undergo a thorough review at key decision points in line with Line Office and program office project review standards. These reviews should offer a real option for significant redirection or divestment

from the project if performance standards are not achieved or mission needs are not being met.

- Development of "off ramps" in the event that development or demonstration is not successful
    - Even well planned transition projects may fail at any RL for a wide range of reasons, but part of the transition plan should include steps to mitigate the risk of failure.
    - Divestment from failed transition projects, or those that no longer are critical for mission deployment, is essential to preserve the available agency resources for other potentially successful transition projects.

C. How to Handle Invention(s)

Prior to any public disclosure of a new and novel technology, the technology manager should contact the NOAA Technology Partnerships Office and discuss the need to disclose project details using the form CD-240. Disclosure kicks off the process for determining ownership and inventorship of any new technology and may help to indicate new pathways for getting a technology into use

D. Considerations for Dealing with Failure of a Transition Project

Transition projects have a specific set of performance metrics and milestones to complete each RL. If a transition project has failed to meet the performance metrics or milestones as expected, the project should be carefully reviewed by appropriate lab/office leadership to analyze the root cause of underperforming or missing the milestones. If the transition project is increasing the risk of failure, remedial steps may be taken to salvage the project. If remedial steps prove to be unsuccessful at correcting project shortcomings, the transition project should be considered for divestment.

Divestment from a transition project can occur in several ways, including termination of the project or transfer of the project to an extramural partner. Any decisions to divest from a transition project should proceed in accordance with Line Office standards and policies.

E. Cadence of Transition and for Monitoring Transition

1. Cadence of Transition

Movement through the R&D phases and individual RLs is specific to each project and seldom at a linear pace. The early stages of development (RL 3) might require much more time than the late stages of demonstration (RL 8), or for some projects the opposite might be the case. Given the irregular pace of progress through the stages, program managers, supervisors, and other reviewers must be cautious when using rate of maturation as part of the monitoring process.

2. Cadence of Monitoring Transition

The cadence of monitoring progress towards R&D transition to regular use or final deployment or implementation depends on several factors including, but not limited to: total cost of the project (e.g., more expensive projects may require more review), federal government budget cycles, seasonal cycles (e.g., hurricane season), internal NOAA or Line Office planning or review cycles, and sponsoring program review cycles. The cadence of monitoring will also be influenced by the duration of the transition project and the timeline for transition milestones.

3. The Concept of Key Decision Points

Within the transition process for a given project there are logical key decision points for significant review. These key decision points are an essential part of the process that establishes approval to continue with and move to the next step in the transition pathway. Planning to advance a transition project can often represent a commitment of one or more years of dedicated resources. Having project-specific key decision points are thus critical to organizational excellence by serving as pre-planned, and agreed on, opportunities for reviews with respective program managers and project supervisors, course corrections, or even potential divestment from a project with no likelihood of successful transition. The Transition Project Leads should agree on the key decision points and scale them proportionally to the scale and scope of the project. These agreed-upon key decision points could be formally included in the transition plan if desired.

Chapter 4 – Governance, Roles, and Responsibilities for Transition of Research and Development

A. Purpose

This Chapter outlines some of the key aspects for managing transition projects through their total lifecycle. The information highlighted in this Chapter is in addition to standard project or program management practices that are more widely used and should be followed routinely with any project.

B. Who Should Monitor Transition of R&D

1. Transition Project Leads

Transition Project Leads and their immediate supervisors are the first line of oversight on a transition project, and as such are the most responsive and engaged for governance and monitoring progress of the project. Transition Project Leads are responsible for setting milestones and managing the resources for a transition project on a day-to-day basis. In their capacity, they should maintain a good working relationship with their respective LOTMs as well as all partnering units from other parts of the agency.

2. Line Office Transition Managers (LOTMs)

LOTMs or their delegates are responsible for periodic transition monitoring within and between line offices (in the case of projects transitioning from one line office to another). The LOTMs should work together to monitor the NOAA transition portfolio.

LOTMs or their delegates are also the key line office point of contact for Transition Project Leads with respect to the transition process. In this capacity, LOTMs will be informed on all aspects of the transition by the Transition Project Leads.

LOTMs or their delegates will monitor progress and status of transition projects compared to their approved Transition Plan, and are empowered to recommend changes to the transition plans as needed.

3. Line Office Assistant Administrators (AAs)

Line Office Assistant Administrators (AAs) are responsible for promoting the goals and implementing the requirements of this NAO on transition, and appointing the respective LOTMs to ensure appropriate oversight of transition projects for the Line Office.

Chapter 5 – Reporting on Transition of Research and Development

A. **Purpose**

This Chapter describes the recommended approach for reporting on transition projects throughout their total life cycle.

B. **Who Reports on Transition**

LOTMs, program managers, and Transition Project Leads are responsible for reporting on the execution status of transition projects. Depending on programmatic or Line Office requirements, this may be necessary as often as quarterly. At a minimum, reporting should be done in line with the requirements of Line Office level annual operating plans (AOPs). There may also be additional reporting requirements specific to the program that is funding the transition project.

Appendix A – References for this Handbook

Dorman, C., 1999. Technology Infusion Panel - Summary Report, Memorandum to Jack Kelly, 15 March, 1999, National Weather Service, Silver Spring, Maryland.

Mankins, J.C. (6 April 1995). Technology Readiness Levels: A White Paper (PDF). NASA, Office of Space Access and Technology, Advanced Concepts Office.

NRC, 2000. From Research to Operations in Weather Satellites and Numerical Weather Prediction: Crossing the Valley of Death. Board on Atmospheric Sciences and Climate, National Research Council, 96 p.

NRC, 2003. Satellite Observations of the Earth's Environment: Accelerating the Transition of Research to Operations. Space Studies Board, National Research Council, 182 p.

SAB, 2004, Review of the Organization and Management of Research in NOAA: A Report to the NOAA Science Advisory Board, August 6, 2004. ftp://ftp.oar.noaa.gov/SAB/sab/Reports/RRT_Report-080604.pdf

Straub, J., 2015. In search of technology readiness level (TRL) 10. Aerospace Science and Technology 46, p. 312-320.

Appendix B – Abbreviations used in this Handbook

AA	Assistant Administrator
AGM	Annual Guidance Memorandum
AOP	Annual operating plan
CONOPS	Concept of operations
COTS	Commercial off-the-shelf
DAA	Deputy Assistant Administrator
DoC	U.S. Department of Commerce
DoD	U.S. Department of Defense
LOTM	Line Office Transition Manager
LOTMC	Line Office Transition Managers Committee
NAO	NOAA Administrative Order
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
R&D	Research and/or development
RFP	Request for proposals
RL	Readiness level
SRGM	Strategic Research Guidance Memorandum

Appendix C – Example Milestones For Each Readiness Level (RL)

Below is a figure adapted from NASA[12] to illustrate the requirements for a project to be cited as "at RL X." To be at a given RL, all components of your project must have completed all of the preceding milestones. For example, to be considered RL 5, all project components must have completed every milestone indicated above RL 5 in this figure. While the project is at RL 5, it should be working on any of the milestones at or below RL 5.

[12] http://www.nasa.gov/sites/default/files/files/ARLMilestonesFigure10712.pdf


❑ Baseline research conducted and documented
❑ Technology or application components formulated and created
RL 2
❑ Ideas for mission application developed
❑ All technology or application components tested individually
❑ Technical or application components formulated and created
❑ Prospective business case for the technology or application
❑ Transition project reviewed by relevant leadership (transition phase checkpoint)
RL 3
❑ Components of eventual system brought together and technical integration issues worked out
❑ Convincing business case for the viability of technology or application
❑ Initial CONOPS developed
❑ Organizational challenges identified and managed
RL 4
❑ Application or technology components integrated into a functioning prototype system with realistic supporting elements
❑ Well-developed business case for complete life cycle
❑ Formal Transition Plan developed
RL 5
❑ Prototype system beta-tested in a simulated relevant environment
❑ Projected improvements over existing systems achieved in a simulated relevant environment
❑ Transition project reviewed by relevant leadership (suggested key decision point)
RL 6
❑ Prototype system integrated into a relevant environment
❑ Prototype system tested for functionality and initial demonstration potential in a relevant environment
RL 7
❑ Prototype system tested and demonstrated full potential in a relevant environment
RL 8
❑ Finalized system tested and demonstrated full potential in a relevant environment
❑ System qualified for deployment by end user
❑ End user documentation and training completed
RL 9
Sustained deployment

Appendix D – Example Transition Plan Template

A Transition Plan should be as concise as possible and commensurate with scope/complexity/maturity of the project. An example Transition Plan for a more mature project is outlined below. A transition plan for a less mature project might be expected to only address a few of the elements outlined below per guidance from the respective AA or their designee, and/or respective LOTM(s).

Example Transition Plans are available on the NOAA Research Council website[13]. More examples will be added there as they become available.

1. Purpose/Objective
2. Research background
3. Business case
   - 3.1. Who are the possible end users?
   - 3.2. Societal and economic benefits
   - 3.3. User Requirements
   - 3.4. Current (demonstration) system
   - 3.5. Justification/acceptance criteria for transition
   - 3.6. Optional transition project rejection release statement[14]
4. Capabilities and Functions
   - 4.1. Current (where is it now?)
   - 4.2. Operational/Application (description of intended end state)
   - 4.3. Data collection and management
5. Transition Activities:
   - 5.1. Identify any "gates" and associated documentation for accomplishing progress from one readiness level to another required to be met by the appropriate Line Offices
   - 5.2. Identify any testbed and proving ground that will be involved
   - 5.3. Identify any possible new technology development
6. Schedule and deliverables
   - 6.1. Implementation Plan
   - 6.2. Milestones
   - 6.3. Training manuals
   - 6.4. Mechanism for updating the plan
7. Roles and Responsibilities (for the Transition)
8. Budget overview
   - 8.1. Cost of current system
   - 8.2. Cost of transition
   - 8.3. Cost of operational system and maintenance

[13] http://nrc.noaa.gov/NOAARDPolicies/ExampleTransitionPlans.aspx

[14] Example: Either Party may at any stage of the transition project terminate plans for further development or final transition acceptance by giving 60 days written notice authorized by the AA or their delegate.

8.4. Optional financial release statement[15]

9. Impacts of Transition
   9.1. Budget- spend plan (proportional resolution appropriate to scale, scope, and maturity of project)
   9.2. Risks and mitigation
10. References
11. Signature page

[15] Example: The Parties specifically acknowledge that this transition plan does not constitute an obligation of funds.

Appendix E – Recommended Process for Completing a Formal Transition Plan

1. Purpose:

The purpose of this document is to describe the process involved in the official review and approval of Transition Plans by the NOAA management.

2. Background:

The NOAA Administrative Order (NAO) 216-105B states that all projects that seek to advance beyond Readiness Level 4 are recommended to have a transition plan. It is reasonable to expect that projects that are less mature and many years from implementation may have less developed transition plans that may not require the full review or approval process outlined below. Ultimately, each AA or their delegate can set the requirements and expectations for Transition Plans for their Line Office, and that will directly influence any review or approval process.

3. Review and Approval Process:

There are three stages in the transition plan review and approval process if the AA or their delegate decide that a particular transition project warrants a full or formal transition plan. The first stage is the working level review and approval, the second stage is the affected Line Office Transition Manager's (LOTM) review and approval, the third stage is the affected Line Office Assistant Administrator's (AA) review and approval with signature for the record.

I. In the working level stage, the Transition Project Lead (i.e., principal investigator) of the project, in coordination with the transition team, is responsible for development of a draft transition plan. This draft transition plan must be reviewed and approved by the division chiefs or other resource managers of both R&D and receiving sides. Once the draft transition plan is approved at the division chief's level, it will be submitted to the responsible LOTM to start the formal review and approval process.

II. In the second stage, the affected LOTMs coordinate the review and approval process of the draft transition plan following his/her Line Office's procedures. For projects involving multiple Line Offices, the LOTMs will coordinate the review and approval across the Line Offices.

III. In the third stage of the review process, the affected LOTM coordinates with the Line Office (LO) clearance process to start the formal review and approval process by the affected LO Assistant Administrator (AA) or their delegate(s), to produce the finalized transition plan, signed by the relevant AA(s) or their delegate(s).

Appendix D: Datasheet

Data Source	OAR FMC	Transition	End User	Meets the Definition of Transition	Function Type	Output Type	Recipient Number	Recipient type	Application Type	OAR Stragteic Goal	NOAA S&T
AOP	ESRL CSD	NOy-CARDS	High-Precision Devices; Boulder , CO	no	Development: Emerging Technologies	Technology: System Service	Single	Cannot Determine	Environmental Intelligence	Integrated Earth Observing Systems	Not Applicable
AOP	GFDL	Provide quasi-operational monthly products for the North American Multi-Model Ensemble (NMME) to NCEP/CPC.	NWS	no	Development: Predictions and Projections	Science: Synthesized Product	Single	Federal Government: NOAA	Environmental Intelligence	Integrated Earth Observing Systems	Artificial Intelligence Strategy
AOP	NSGO	Advancing Eastern Oyster Aquaculture through Marker-assisted Selection (R/Guo (NJ-NA14OAR4170085); 9845)		no	Research: Studies and Assessments	Science: Interpreted Product	Cannot Determine	Cannot Determine	Resource Management	Healthy Oceans	Omics Strategy
AOP	WPO	USWRP Hazardous Weather Testbed 15	NWS, NCEP, SPC	yes	Transition: Extension and Outreach	Science: Interpreted Product	Several	Federal Government: NOAA	Emergency Management	Integrated Environmental Modeling System	Artificial Intelligence Strategy
AOP	UAS	UASPO FY19 Grants "2019-09"	NWS	yes	Transition: Extension and Outreach	Technology: Standards Protocols	Single	Federal Government: NOAA	Commerce	Resilient Coastal Communities and Economies	Uncrewed Systems Strategy
AOP/NRDD	UAS	UASPO FY17 Grants "2017-17"	OAR/PMEL, other NOAA researchers	yes	Transition: Extension and Outreach	Technology: Standards Protocols	Infinite	Federal Government: NOAA	Commerce	Resilient Coastal Communities and Economies	Uncrewed Systems Strategy
NRDD	NSGO	Applied Research for a New Seaweed Aquaculture Industry in Alaska		no	Research: Studies and Assessments	Science: Original Data	Cannot Determine	Cannot Determine	Resource Management	Healthy Oceans	Omics Strategy
NRDD	NSGO	Managing the complex profile of biotoxins threatening the shellfish industry of Lower Chesapeake Bay	NESDIS/NCEI, General Public	no	Research: Studies and Assessments	Science: Interpreted Product	Infinite	Multiple Users	Resource Management	Resilient Coastal Communities and Economies	Omics Strategy
NRDD	NSGO	The biogeochemical habitat of wild rice	General Public, Educators	no	Research: Studies and Assessments	Science: Interpreted Product	Infinite	Multiple Users	Resource Management	Resilient Coastal Communities and Economies	Not Applicable
NRDD	NSGO	Long-term aquatic conditions to inform delisting efforts on the St. Louis River	General Public, Educators	no	Research: Studies and Assessments	Science: Interpreted Product	Infinite	Multiple Users	Education/Learning	Resilient Coastal Communities and Economies	Not Applicable
AOP	AOML	Environmental conditions in Gulf of Mexico for Bluefin Tuna stock assessments	NMFS	yes	Transition: Extension and Outreach	Science: Synthesized Product	Single	Federal Government: NOAA	Resource Management	Healthy Oceans	Data Strategy
AOP	AOML	Global Vibrio Risk fields	NOS, ECDC (European Center for Disease Prevention and Control)	yes	Transition: Extension and Outreach	Technology: Standards Protocols	Several	Multiple Users	Commerce	Healthy Oceans	Omics Strategy
AOP	AOML	HFIP (Hurricane Forecast Improvement Project) Observations	NCEP/EMC	yes	Transition: Technology Transfer	Science: Original Data	Single	Federal Government: NOAA	Emergency Management	Weather Ready Nation	Data Strategy
AOP	AOML	HFIP (Hurricane Forecast Improvement Project) Observations	NCEP/NHC, NCEP/CPHC, NWS/WFOs	yes	Transition: Technology Transfer	Science: Original Data	Several	Federal Government: NOAA	Emergency Management	Weather Ready Nation	Data Strategy
AOP	AOML	Hurricane Underwater Gliders	NWS, IOOS, DOD	yes	Transition: Technology Transfer	Technology: Hardware Equipment	Several	Federal Government: Other	Emergency Management	Weather Ready Nation	Uncrewed Systems Strategy

AOP	AOML	MST Technology Transition for LBSP-Impacted Saipan Coastal Water to Guide Coral Management	CNMI-BECQ	yes	Transition: Extension and Outreach	Technology: System Service	Single	International	Resource Management	Healthy Oceans	Omics Strategy
AOP	AOML	State of the Climate Articles	NOAA	yes	Transition: Extension and Outreach	Science: Interpreted Product	Single	Federal Government: NOAA	Education/Learning	Climate Adaptation and Mitigation	Not Applicable
AOP	AOML	Subsurface Automatic Samplers	OAR, NMFS, Mote, UM	yes	Transition: Technology Transfer	Technology: Hardware Equipment	Several	Multiple Users	Environmental Intelligence	Healthy Oceans	Uncrewed Systems Strategy
AOP	ARL	HYSPLIT operations at the NWS	NWS	yes	Transition: Technology Transfer	Technology: Model Algorithm	Single	Federal Government: NOAA	Environmental Intelligence	Integrated Environmental Modeling System	Artificial Intelligence Strategy
AOP	ARL	HYSPLIT operations at the NWS	NWS	yes	Transition: Technology Transfer	Technology: Model Algorithm	Single	Federal Government: NOAA	Environmental Intelligence	Integrated Environmental Modeling System	Artificial Intelligence Strategy
AOP	ARL	HYSPLIT READY web site	NOAA, DOD, DOE, EPA, academia, national and international reserach community	yes	Transition: Extension and Outreach	Technology: System Service	Infinite	Multiple Users	Environmental Intelligence	Stakeholder Engagement	Not Applicable
AOP	ARL	Support to the National Air Quality Forecasting Capability (NAQFC)		yes	Transition: Extension and Outreach	Technology: Model Algorithm	Cannot Determine	Cannot Determine	Environmental Intelligence	Integrated Environmental Modeling System	Data Strategy
AOP	CPO	CPO		yes	Transition: Extension and Outreach	Science: Interpreted Product	Cannot Determine	Cannot Determine	Environmental Intelligence	Climate Adaptation and Mitigation	Not Applicable
AOP	CPO	NIHHIS	Climate community and public	yes	Transition: Extension and Outreach	Science: Interpreted Product	Infinite	Multiple Users	Research	Climate Adaptation and Mitigation	Not Applicable
AOP	CPO	OOMD		yes	Transition: Extension and Outreach	Science: Interpreted Product	Cannot Determine	Cannot Determine	Education/Learning	Climate Adaptation and Mitigation	Not Applicable
AOP	ESRL CSD	FAST-LVOS	Clark County, NV, Department of Air Quality	yes	Transition: Technology Transfer	Science: Original Data	Single	State/Local/Tribal Government	Environmental Intelligence	Climate Adaptation and Mitigation	Data Strategy
AOP	ESRL GMD	CarbonTracker	BAMS Annual State of the Climate Report	yes	Transition: Extension and Outreach	Science: Synthesized Product	Infinite	Multiple Users	Environmental Intelligence	Integrated Environmental Modeling System	Data Strategy
AOP	ESRL GMD	High Quality Climate Observations		yes	Transition: Extension and Outreach	Science: Original Data	Cannot Determine	Cannot Determine	Environmental Intelligence	Climate Adaptation and Mitigation	Data Strategy
AOP	ESRL GMD	High Quality Climate Observations	BAMS Annual State of the Climate Report	yes	Transition: Extension and Outreach	Science: Synthesized Product	Infinite	Multiple Users	Environmental Intelligence	Climate Adaptation and Mitigation	Data Strategy
AOP	ESRL GSD	Convection-Allowing Model (CAM) ensemble post-processing code transitions to NWS operations in High Resolution Ensemble Forecast (HREF) v3.0 model which will replace HREF v2.1 that was cancelled as a result of the NCO moratorium of new code implementation on WCOSS.	NWS	yes	Transition: Technology Transfer	Technology: Model Algorithm	Single	Federal Government: NOAA	Environmental Intelligence	Integrated Environmental Modeling System	Artificial Intelligence Strategy

AOP	ESRL GSD	O2R - Assist Developmental Testbed Center (DTC) with Common Community Physics Package (CCPP) V3.0 public release	Public modeling community	yes	Transition: Technology Transfer	Science: Synthesized Product	Infinite	Multiple Users	Environmental Intelligence	Integrated Environmental Modeling System	Not Applicable
AOP	ESRL GSD	O2R - Developmental Testbed Center (DTC) releases NCEP Unified Post Processor (UPP) Version 4.0 to the modeling community and updated User Guide documentation to include information on post-processing the FV3GFS model output	Public modeling community	yes	Transition: Technology Transfer	Technology: Model Algorithm	Infinite	Multiple Users	Education/Lear ning	Stakeholder Engagement	Artificial Intelligence Strategy
AOP	ESRL GSD	O2R--Developmental Testbed Center (DTC) delivers GSI v3.7 and EnKF v1.3 updated code to the community.	Public modeling community	yes	Transition: Technology Transfer	Technology: Model Algorithm	Infinite	Multiple Users	Education/Lear ning	Stakeholder Engagement	Artificial Intelligence Strategy
AOP	ESRL GSD	O2R--Developmental Testbed Center (DTC) releases HWRF 4.0 a to the modeling community	Public modeling community	yes	Transition: Technology Transfer	Technology: Model Algorithm	Infinite	Multiple Users	Education/Lear ning	Stakeholder Engagement	Artificial Intelligence Strategy
AOP	ESRL GSD	Operational deployment of Meterological Assimilation Data Ingest System (MADIS) v2.2	NWS	yes	Transition: Technology Transfer	Technology: Model Algorithm	Single	Federal Government: NOAA	Environmental Intelligence	Integrated Earth Observing Systems	Artificial Intelligence Strategy
AOP	ESRL GSD	Public release of GSD's SOS Explorer™ Mobile App for Apple and Android Devices (Chromebook, iPhone, etc)	General Public, Educators	yes	Transition: Extension and Outreach	Technology: System Service	Infinite	Multiple Users	Education/Lear ning	Stakeholder Engagement	Not Applicable
AOP	ESRL PSD	NGGPS Improvements*	NCEP/CPC, NCEP/EMC, NWS forecast offices	yes	Transition: Technology Transfer	Science: Synthesized Product	Several	Federal Government: NOAA	Environmental Intelligence	Integrated Earth Observing Systems	Data Strategy
AOP	GFDL	Next-generation models for World Climate Research Program model intercomparison projects.	WCRP, NOAA, Academic Community	yes	Transition: Technology Transfer	Technology: Model Algorithm	Infinite	Multiple Users	Environmental Intelligence	Integrated Environmental Modeling System	Artificial Intelligence Strategy
AOP	GLERL	Great Lakes Coastal Forecast System: Lakes Michigan-Huron	NOS/CO-OPS	yes	Transition: Technology Transfer	Technology: Model Algorithm	Single	Federal Government: NOAA	Environmental Intelligence	Integrated Environmental Modeling System	Not Applicable
AOP	NSGO	Barrier Beach Breaching and Bay Flooding (R/RCE-9 (DE-NA14OAR4170087) 11578)	USACE, FEMA	yes	Transition: Extension and Outreach	Science: Interpreted Product	Several	Federal Government: Other	Emergency Management	Integrated Earth Observing Systems	Not Applicable
AOP	NSSL	FLASH Full Implementation	NWS	yes	Transition: Technology Transfer	Science: Interpreted Product	Single	Federal Government: NOAA	Emergency Management	Resilient Coastal Communities and Economies	Not Applicable
AOP	NSSL	MRMS v.12	NWS, FAA	yes	Transition: Technology Transfer	Technology: Model Algorithm	Several	Federal Government: Other	Commerce	Integrated Earth Observing Systems	Artificial Intelligence Strategy
AOP	NSSL	WSR-88D NPI Algorithms	NWS, FAA, DOD	yes	Transition: Technology Transfer	Technology: Model Algorithm	Several	Federal Government: Other	Commerce	Integrated Environmental Modeling System	Artificial Intelligence Strategy
AOP	NSSL	WSR-88D NPI Algorithms	NWS, FAA, DOD	yes	Transition: Technology Transfer	Technology: Model Algorithm	Several	Federal Government: Other	Commerce	Integrated Environmental Modeling System	Artificial Intelligence Strategy
AOP	NSSL	WSR-88D NPI Algorithms	NWS, FAA, DOD	yes	Transition: Technology Transfer	Technology: Model Algorithm	Several	Federal Government: Other	Commerce	Integrated Environmental Modeling System	Artificial Intelligence Strategy

AOP	OA	Ocean Acidification Capacity Building and Outreach (IWG-OA Theme 6)		yes	Transition: Extension and Outreach	Science: Tacit Expertise	Cannot Determine	Cannot Determine	Education/Lear ning	Stakeholder Engagement	Not Applicable
AOP	OA	Ocean Acidification Monitoring Activities (IWG-OA SP Theme 1)		yes	Transition: Technology Transfer	Science: Synthesized Product	Cannot Determine	Cannot Determine	Environmental Intelligence	Healthy Oceans	Data Strategy
AOP	OA	Ocean Acidification Monitoring Activities (IWG-OA SP Theme 1)		yes	Transition: Technology Transfer	Science: Original Data	Cannot Determine	Cannot Determine	Environmental Intelligence	Healthy Oceans	Data Strategy
AOP	OA	Ocean Acidification Monitoring Activities (IWG-OA SP Theme 1)		yes	Transition: Technology Transfer	Science: Original Data	Cannot Determine	Cannot Determine	Environmental Intelligence	Healthy Oceans	Data Strategy
AOP	OA	Ocean Acidification Monitoring Activities (IWG-OA SP Theme 1)		yes	Transition: Technology Transfer	Science: Original Data	Cannot Determine	Cannot Determine	Environmental Intelligence	Healthy Oceans	Data Strategy
AOP	OA	Ocean Acidification Research Activities (IWG-OA SP Theme 2)		yes	Transition: Extension and Outreach	Science: Interpreted Product	Cannot Determine	Cannot Determine	Education/Lear ning	Healthy Oceans	Not Applicable
AOP	OA	Ocean Acidification Research Activities (IWG-OA SP Theme 2)		yes	Transition: Extension and Outreach	Science: Interpreted Product	Cannot Determine	Cannot Determine	Education/Lear ning	Healthy Oceans	Data Strategy
AOP	OA	Ocean Acidification Research Activities (IWG-OA SP Theme 2)		yes	Transition: Extension and Outreach	Science: Interpreted Product	Cannot Determine	Cannot Determine	Education/Lear ning	Healthy Oceans	Data Strategy
AOP	OA	Ocean Acidification Technology & Standardization of Measurements (IWG-OA Theme 4)		yes	Transition: Extension and Outreach	Science: Interpreted Product	Cannot Determine	Cannot Determine	Education/Lear ning	Healthy Oceans	Data Strategy
AOP	OA	Ocean Acidification Vulnerability Assessments (IWG-OA Theme 5)		yes	Transition: Extension and Outreach	Science: Interpreted Product	Cannot Determine	Cannot Determine	Education/Lear ning	Healthy Oceans	Data Strategy
AOP	WPO	Research Transition Acceleration Program	NWS	yes	Transition: Technology Transfer	Technology: Model Algorithm	Single	Federal Government: NOAA	Emergency Management	Integrated Earth Observing Systems	Artificial Intelligence Strategy
AOP	UAS	UASPO FY17 Grants "2017-10"	NOAA	yes	Transition: Extension and Outreach	Technology: Standards Protocols	Single	Federal Government: NOAA	Commerce	Resilient Coastal Communities and Economies	Uncrewed Systems Strategy
AOP	UAS	UASPO FY18 Grants "2018-02"	NMFS	yes	Transition: Technology Transfer	Technology: Hardware Equipment	Single	Federal Government: NOAA	Resource Management	Healthy Oceans	Uncrewed Systems Strategy
AOP	UAS	UASPO FY19 Grants "2019-08"	NOS	yes	Transition: Extension and Outreach	Technology: Standards Protocols	Single	Federal Government: NOAA	Commerce	Resilient Coastal Communities and Economies	Uncrewed Systems Strategy
AOP	UAS	UASPO FY17 Grants "2017-07"	NMFS	yes	Transition: Extension and Outreach	Science: Synthesized Product	Single	Federal Government: NOAA	Resource Management	Healthy Oceans	Uncrewed Systems Strategy
AOP	UAS	UASPO FY18 Grants "2018-03"	NMFS	yes	Transition: Extension and Outreach	Science: Synthesized Product	Single	Federal Government: NOAA	Resource Management	Healthy Oceans	Uncrewed Systems Strategy
AOP	UAS	UASPO FY19 Grants "2019-01"	NMFS	yes	Transition: Technology Transfer	Technology: Hardware Equipment	Single	Federal Government: NOAA	Resource Management	Healthy Oceans	Artificial Intelligence Strategy
AOP	UAS	UASPO FY19 Grants "2019-04"	NMFS	yes	Transition: Technology Transfer	Technology: Model Algorithm	Single	Federal Government: NOAA	Resource Management	Healthy Oceans	Artificial Intelligence Strategy

AOP	UAS	UASPO FY19 Grants "2019-05"	NMFS	yes	Transition: Extension and Outreach	Science: Tacit Expertise	Single	Federal Government: NOAA	Resource Management	Healthy Oceans	Artificial Intelligence Strategy
AOP	UAS	UASPO FY19 Grants"2019-12"	ESRL	yes	Transition: Technology Transfer	Technology: Hardware Equipment	Single	Federal Government: NOAA - OAR	Environmental Intelligence	Resilient Coastal Communities and Economies	Uncrewed Systems Strategy
AOP/NRDD	WPO	Joint Technology Transfer Initiative	NWS, NCEP, WPC	yes	Transition: Technology Transfer	Technology: Standards Protocols	Several	Federal Government: NOAA	Environmental Intelligence	Integrated Environmental Modeling System	Artificial Intelligence Strategy
AOP/NRDD	WPO	Joint Technology Transfer Initiative	NWS	yes	Transition: Technology Transfer	Technology: Model Algorithm	Single	Federal Government: NOAA	Environmental Intelligence	Weather Ready Nation	Artificial Intelligence Strategy
NRDD	AOML	AOML Upgrades to the Mandatory Ship Reporting System	Publicly-Available	yes	Transition: Technology Transfer	Technology: Model Algorithm	Infinite	Multiple Users	Resource Management	Healthy Oceans	Artificial Intelligence Strategy
NRDD	AOML	AOML NOAA Inmarset to Iridium XBT transmissions	OAR/AOML	yes	Transition: Technology Transfer	Science: Synthesized Product	Single	Federal Government: NOAA - OAR	Environmental Intelligence	Healthy Oceans	Data Strategy
NRDD	AOML	AOML: Next Generation Generalized Nesting Framework (NGGNF)	NWS/EMC	yes	Transition: Technology Transfer	Technology: Model Algorithm	Single	Federal Government: NOAA	Environmental Intelligence	Integrated Environmental Modeling System	Artificial Intelligence Strategy
NRDD	AOML	AOML: Beach and Coastal Characterization of Microbial Contaminants and Pathogens	Aanderaa Data Instruments, resource managers, public health officials, city/county/state environmental agencies, and the public.	yes	Transition: Technology Transfer	Technology: System Service	Infinite	Multiple Users	Resource Management	Resilient Coastal Communities and Economies	Omics Strategy
NRDD	NSGO	Shellfish Aquaculture and Virus Pollution Near Wastewater Treatment Plants		yes	Transition: Extension and Outreach	Technology: Standards Protocols	Cannot Determine	Cannot Determine	Resource Management	Healthy Oceans	Omics Strategy
NRDD	NSGO	Potential Pollution Trade-Offs for Sustainable Coastal Agricultural Management	General Public	yes	Transition: Technology Transfer	Technology: Standards Protocols	Infinite	Multiple Users	Resource Management	Resilient Coastal Communities and Economies	Not Applicable
NRDD	NSGO	Evaluation of Rapid Brevetoxin Tests for Use in Shellfish Regulation Shellfish Industry and Aquaculture	NOAA	yes	Transition: Technology Transfer	Technology: Hardware Equipment	Several	Federal Government: NOAA	Resource Management	Resilient Coastal Communities and Economies	Omics Strategy
NRDD	NSGO	Sustainable Production of Marine Fish and Sea Vegetables in a Marine Aquaponics System	General Public, Educators	yes	Transition: Technology Transfer	Technology: Hardware Equipment	Infinite	Multiple Users	Resource Management	Resilient Coastal Communities and Economies	Not Applicable
NRDD	NSGO	Economic Viability of a Directed Skate Fishery in the Gulf of Alaska	NMFS	yes	Transition: Technology Transfer	Technology: Model Algorithm	Single	Federal Government: NOAA	Resource Management	Resilient Coastal Communities and Economies	Data Strategy
NRDD	WPO	Post-Processing of CMAQ Air Quality Predictions: Research to Operations	NWS	yes	Transition: Technology Transfer	Technology: Model Algorithm	Single	Federal Government: NOAA	Environmental Intelligence	Integrated Environmental Modeling System	Artificial Intelligence Strategy