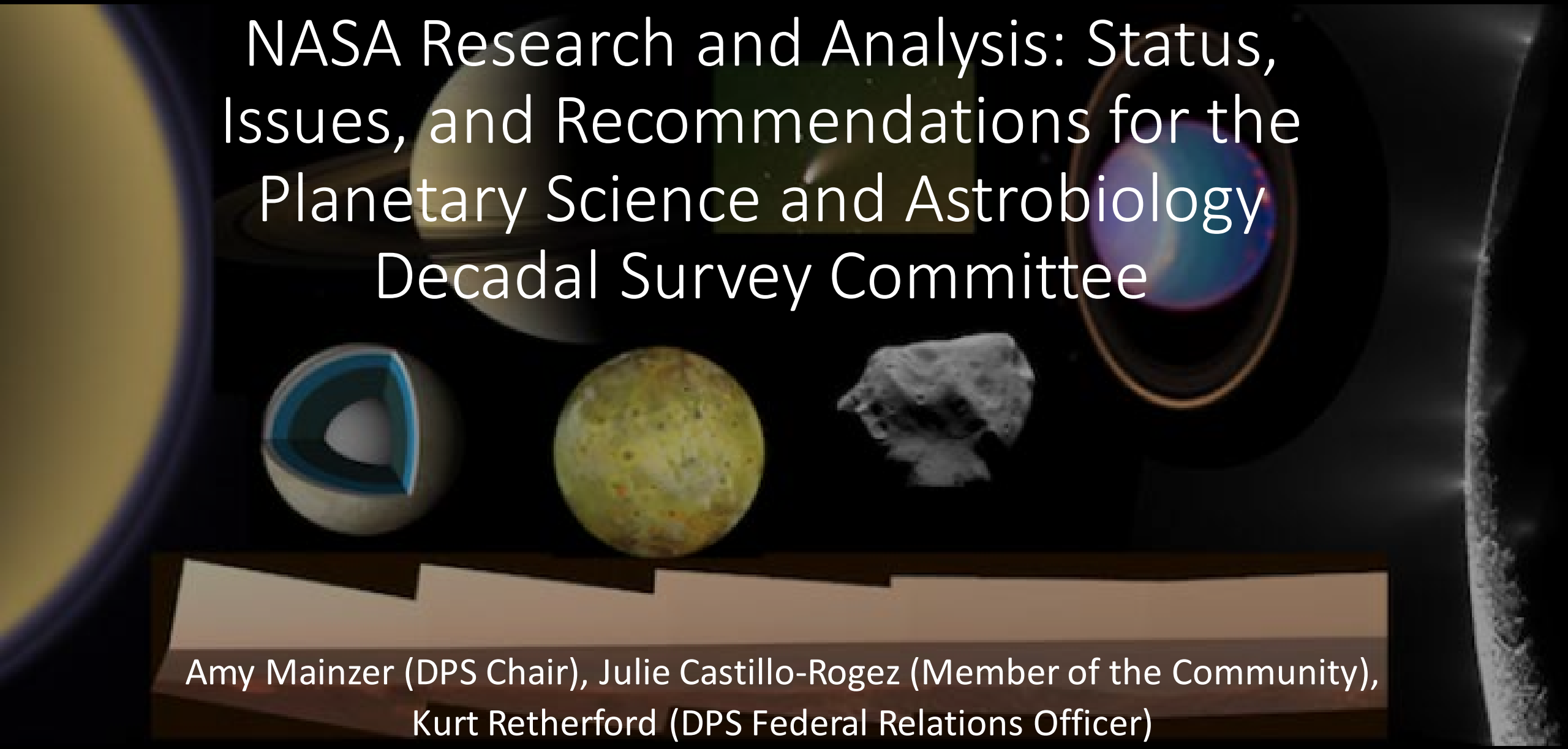
NASA Research and Analysis: Status, Issues, and Recommendations for the Planetary Science and Astrobiology Decadal Survey Committee



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And input from M. Sykes, C. Richey, A. Hendrix, P. Byrne, and J. Rathbun

Science Is at the Core of SMD's Goals

- SMD missions must achieve their original science objectives, with the goal of maximizing scientific productivity beyond their original objectives, e.g.,
  - Spitzer Space Telescope characterizing exoplanet atmospheres: this field of study was not envisioned when Spitzer's Level 1 requirements were defined
  - NEOWISE: Its original Level 1 requirements focused on distant galaxies and brown dwarfs, but it became possible to repurpose it for asteroid & comet science
  - Deep Impact EPOXI: Contributed to lunar hydration discovery following primary comet mission
- Not all planetary R&A research is directly tied to specific missions, but is fundamental to defining their objectives and being able to interpret their data, e.g.,
  - Mapping of sedimentary flows on Mars yield an optimal location to search for evidence of ancient life by Perseverance
  - Understanding of the early solar system has drastically evolved in the past 10 years thanks to the study of meteorites and advances in cosmochemical and dynamical modeling
- A vibrant planetary science program pays important dividends, opening new pathways for exploration, maximizing taxpayers' return on investments in NASA missions, and maintaining US science leadership

Science Provides the "Why" for SMD Missions

- Science is a small fraction of a typical NASA mission: ~5-10% of development cost, which has decreased considerably from past decades
- Mission science teams are motivated by NASA to work toward a limited & often conservative scope of science objectives to maximize the probability of success while limiting cost growth
- R&A develops knowledge essential to expanding the scientific ambitions of our missions. It allows new ideas to be matured to determine which areas are worth investing significant resources in, ensuring that best ideas go forward
  - Note: instrumentation maturation programs are key to enabling reliable, flight-ready technology, and might better be considered separately from R&A
- R&A allows our community to maximize science return from NASA's missions over time as new knowledge becomes available

Recommendation: It is critical that R&A remains a top decadal priority

DPS Perspective

- Planetary science is uniquely vulnerable to changes in NASA planetary R&A funding because NASA is the major funding agency for planetary science
- DPS represents a wide array of planetary scientists
  - Our most recent membership survey indicates that research funding is a top concern
- Selection rates in most planetary research programs are low enough now that it is difficult to sustain a career that is primarily supported by planetary R&A
- Low selection rates negatively impact efforts to make planetary science more inclusive, accessible, diverse, and equitable
  - Mission teams tend to be especially lacking in diversity, increasing the dependency on R&A for members of traditionally underrepresented groups in planetary science

Finding: The definition of "research and analysis" (R&A) in NASA's budget is unclear, making it difficult to track adherence to Decadal recommendations

- There is significant variation in what NASA has considered R&A, with multiple budget lines and mixtures of other elements changing year by year (see Mark Sykes' detailed materials)
- NASA should publish the budget of every R&A program element each fiscal year, along with its WBS number in a clear online format
  - As it has implemented for selection rate details on the SARA website
  - And similarly for instrument and technology programs if reported separately
  - NASA should resist mixing non-R&A elements into these reported numbers

Recommendation: The next Decadal Survey report should rigorously define what is and what is not included under the "R&A programs" and direct NASA to do the same

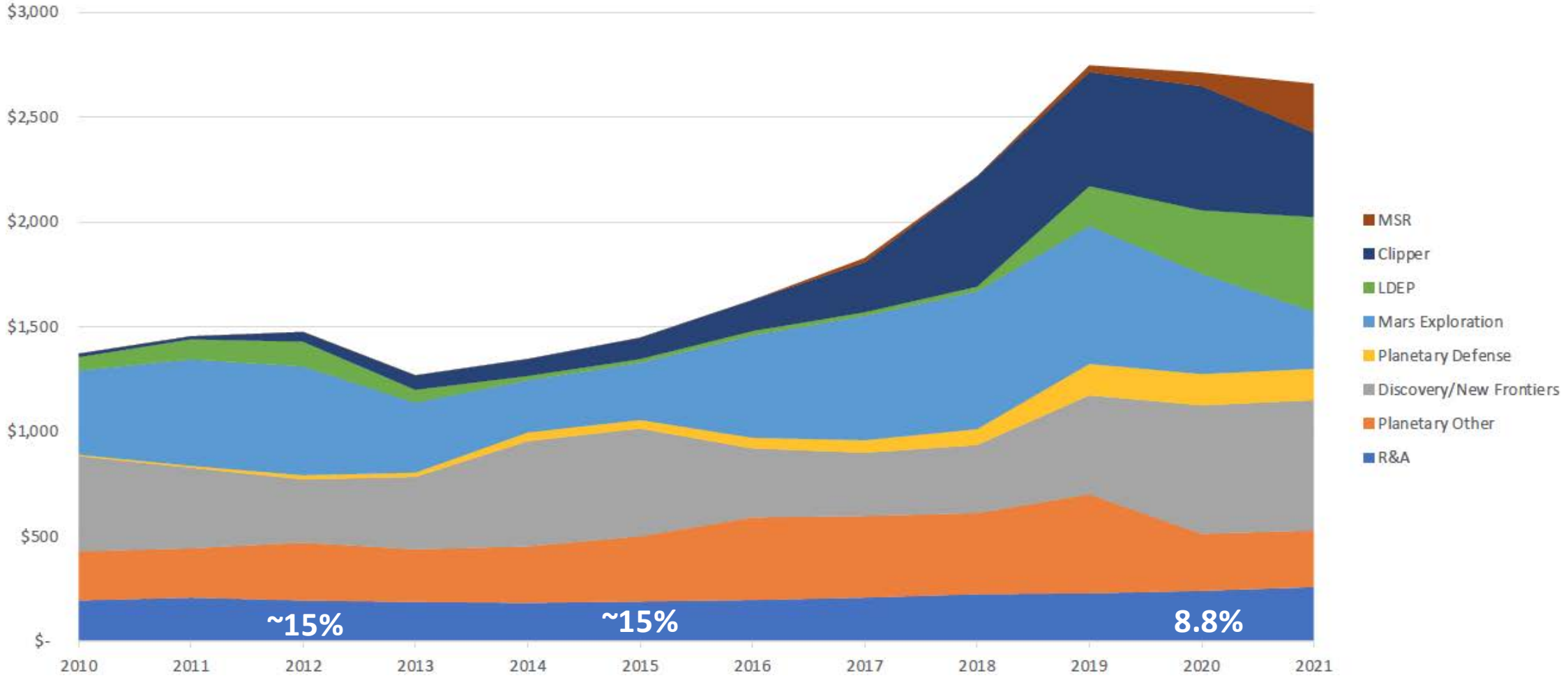
Finding: Programmatic balance is difficult to achieve when selection rates are extremely low

- The current system lacks transparency on what is meant by programmatic balance and how it is implemented when so few proposals are selected. This should be publicly communicated
- When “programmatic balance” is a factor in the selection of a proposal, it should be clearly documented in the selection document
- Changes to the cadence of key programs (e.g., Habitable Worlds) and funding levels is highly disruptive of the balance

Recommendation: NASA should strive for programmatic balance across R&A programs, defining clear criteria for changing a program’s cadence and factors for individual selections

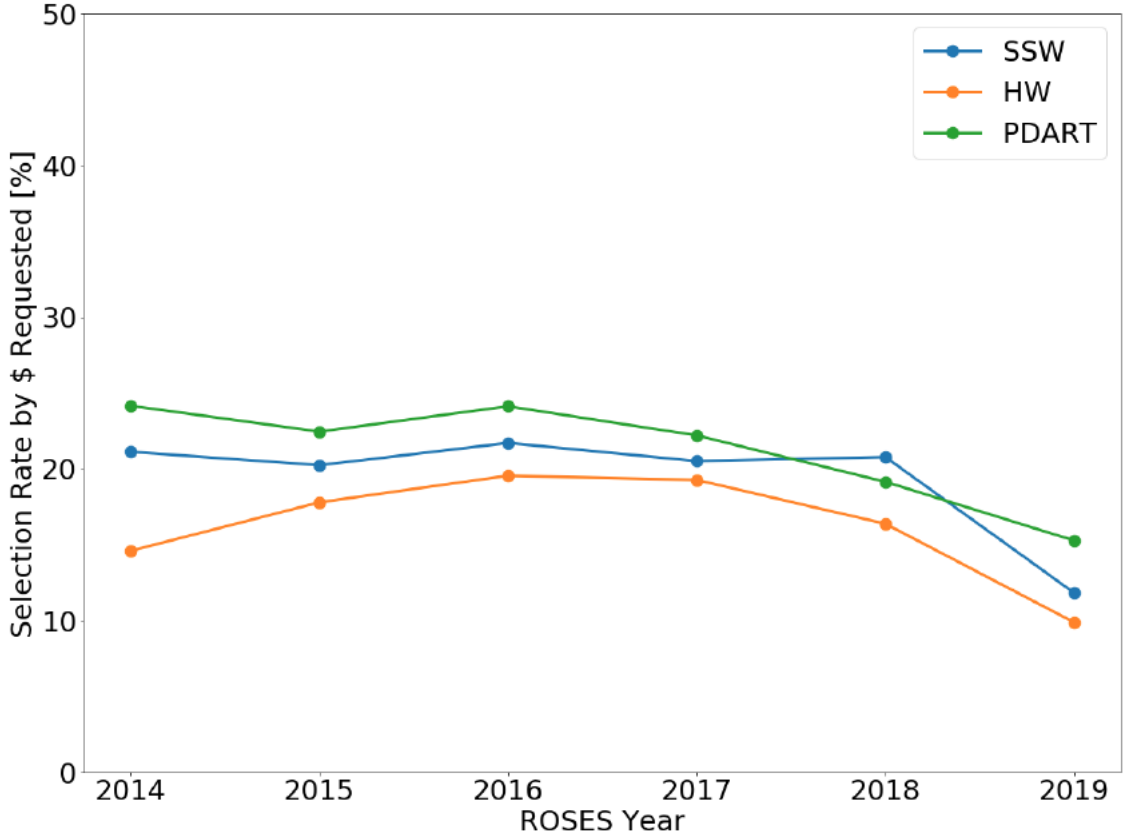
PSD's Budget has ~doubled since the V&V DS, R&A has not

There is a discrepancy between the extent of PSD's current portfolio of activities and support for R&A



Source: S. Rinehart, Presentation to PSADS, Feb 26, 2021

Finding: The PSD R&A program has reached critically low selection rates, to the detriment of NASA's strategic objectives



- Since the last Decadal Survey, the field has grown substantially (esp. Astrobiology)
- With many new missions to new targets, the need for more R&A funds next decade will be greater
- Proposal budgets have increased for reasons that are not yet clear, demonstrating more demand for funding
- The selection rate has remained roughly constant at ~20% for the past decade. However, it dropped to <15% in some programs in 2019 (e.g., 11% for SSW, 4% for PSTAR)

Source: S. Rinehart, Presentation to PSADS, Feb 26, 2021

Finding: Unsustainable selection rates (i.e., <30%) are leading to more complex and expensive proposals and more effort dedicated to proposal writing

- This scenario is not sustainable for a healthy, diverse, and thriving planetary science community
- The prospect of the community losing science experts and innovators (especially those without tenure/hard money) is a very real risk
- Rathbun et al. (2020) point out that low selection rates disproportionately affect members of underrepresented groups, resulting in a less diverse and inclusive workforce

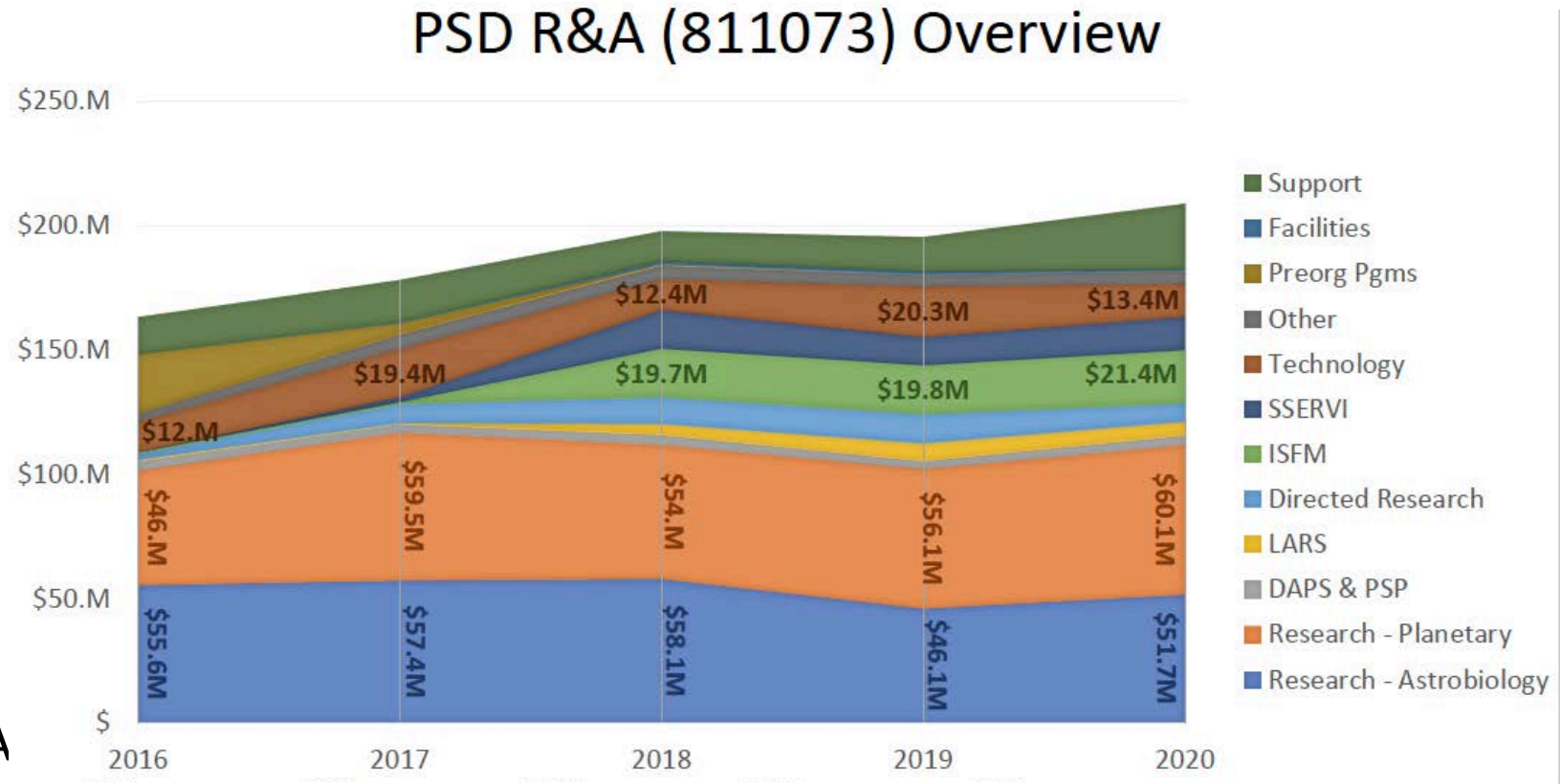
Recommendation: The Decadal Survey should recommend an across the board R&A funding level of >$500M for FY23, at >15% of the PSD budget going forward

- This budget reflects the need to sustain and grow (surely not decrease) our planetary community, as with more missions come more data to analyze
- With improved technologies come more capabilities to analyze both new and old data to maximize the scientific return of NASA missions, which are significantly expanding in diversity of targets, complexity of science questions, and need for infrastructure (e.g., for sample return curation and analysis)
- A near-term selection rate of 40% is appropriate given past shortfalls; Longer term, ~33% rates should be the norm (1 award for 3 proposals written)
- Previous 2003 Decadal recommendation: Funding R&A at 25% of the flight mission budget “is an appropriate allocation of resources” – For 2020, this would be $502M

Finding: The ISFM has the potential to alter the amount of openly competed R&A future funding

- Reallocation of R&A funding through the Internal Scientist Funding Model (ISFM) has not increased the availability of funds that can be accessed by the entire planetary science community in the U.S

- A substantial amount of funding is allocated to contractors via this mechanism
- Approximately 8% of DPS members work at NASA labs (excluding JPL) according to the recent DPS workforce survey
- ISFM funding is $21.4M, roughly 10% of total ~$204M
- Guidance for maintaining the ISFM allocation or better yet tracking it outside of the R&A budgets is recommended to NASA with further study



(Stephen Rinehart, Presentation to PAC Nov 30, 2020)

Key Findings About the R&A Review Process

- Inconsistency in review panel feedback in successive years is a pervasive issue and implies that even if a scientist receives useful information on their proposal from a panel one year, that scientist can have little expectation that a revised proposal will fare any better the next year

- Biases of all kinds toward researchers pervade our community, including in the actual mechanics of proposal peer review

- There is no explicit requirement for, nor means of rewarding, the inclusion of undergraduate, graduate, or postdoctoral researchers on NASA R&A proposals, even when those proposals would materially train such early-career researchers in important research skills

Recommendations About the R&A Review Process

- SMD should review whether the criteria for assessing conflicts of interest are overly broad, especially for programs where candidate reviewer pools are small
- SMD should allow resubmitted proposals above some level threshold to address earlier shortcomings in the manner of peer review for academic manuscripts
- NASA should permit review panels to commend proposals planning to train early career researchers
- Continued implicit bias training is crucial to ensuring that the harm of reviewer and PO biases is minimized, and such training should be expanded to external reviewers

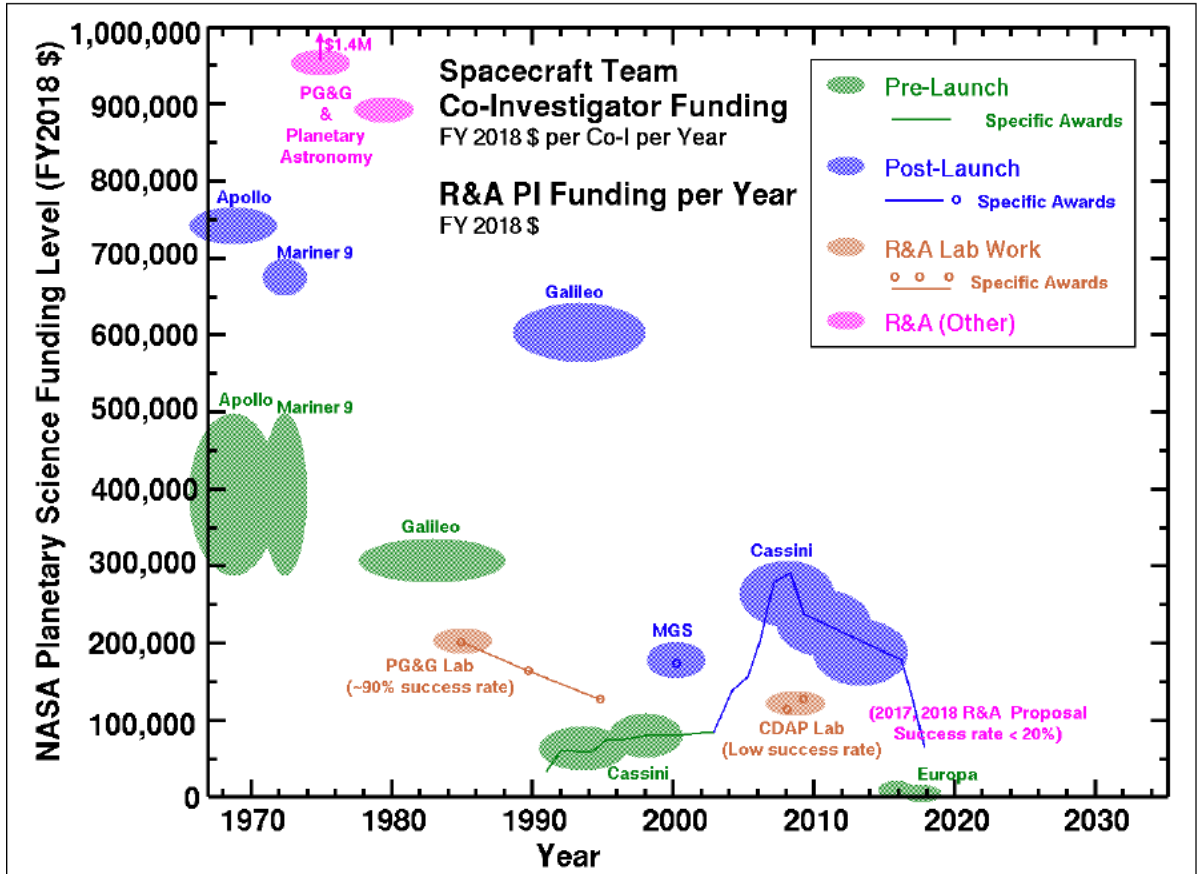
Final Recommendations

- Having strong guidelines and recommendations for R&A in the Decadal is the surest way to help support the future budgets for research, since this is a powerful tool for advocacy on the Hill and is read by the key staffers
- The Decadal should set up a task force on the state of the profession that would (among other things):
  - Work with PSD to frame the goals, extent, and scope of R&A programs and commensurate level of funding
  - Work with professional societies to determine what level of support defines a “healthy” community
  - Assess the total funding levels of scientists through missions during development, nominal mission, and extended mission phases, and determine whether the expected role of R&A to sustain the overall science endeavor is met with reality

Backup Charts

References: White Papers

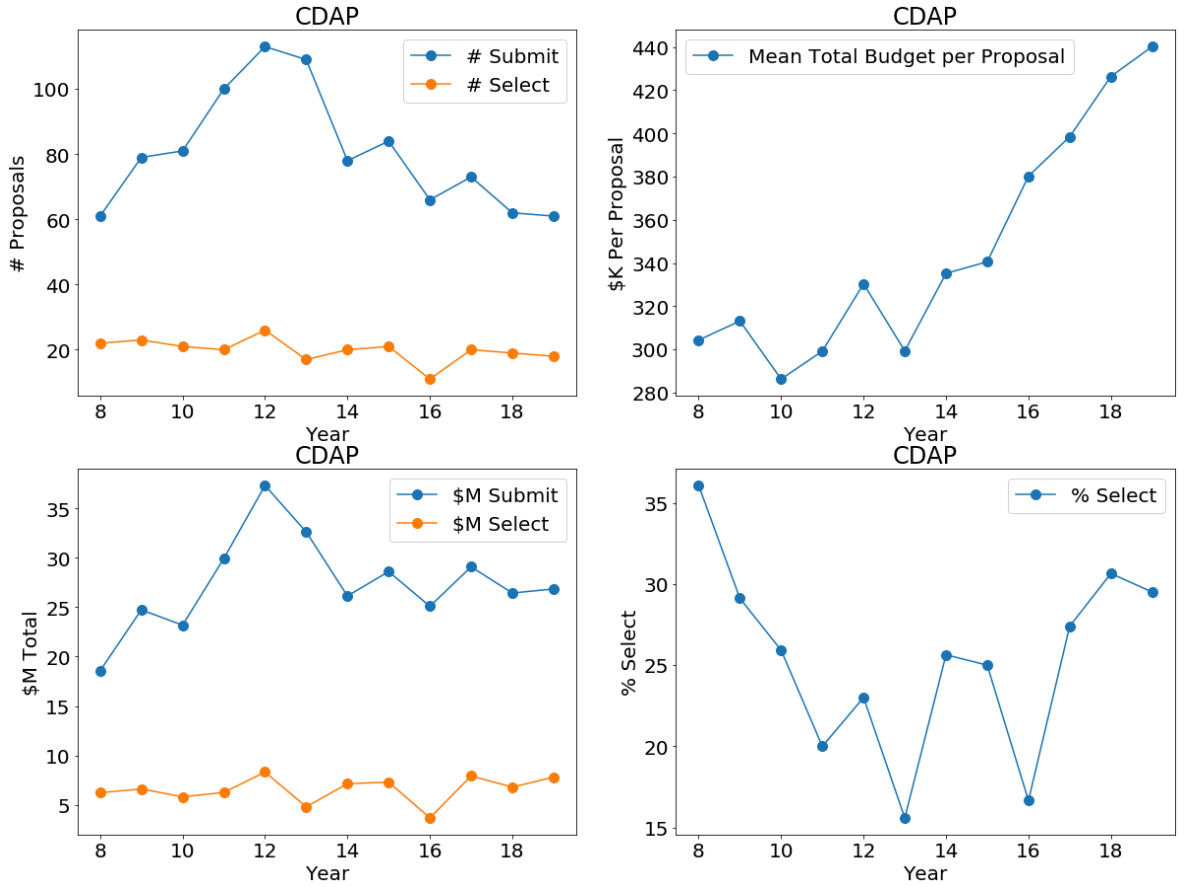
- Bottke & Levison, Tenets of an Effective and Efficient Research and Analysis Program for NASA
- Byrne et al., Improvements to the NASA Research and Analysis Proposal and Review System
- Castillo-Rogez et al., NASA Research and Analysis: Status, Issues, and Recommendations for the Planetary Science and Astrobiology Decadal Survey Committee
- Daubar et al., Extended Missions in Planetary Science: Impacts to Science and the Workforce
- Hendrix et al., Results of the 2020 Planetary Science Workforce Survey conducted by the American Astronomical Society (AAS) Division for Planetary Sciences (DPS)
- Hibbitts et al., Laboratory Architecture as an Infrastructural Capability to Increase the Science Returned by Ocean World Missions
- Rathbun et al., Who is Missing in Planetary Science?: Strategic Recommendations to Improve the Diversity of the Field
- Rathbun et al., The Growing Digital Divide and its Negative Impacts on NASA's Future Workforce
- Retherford et al., Boldly Increase the Planetary Science Research & Analysis Budget by 50% Immediately
- Sykes et al., NASA Planetary Research and Analysis: What is R&A?
- Sykes et al., NASA Planetary Research and Analysis: Strategy for Reorganization



Mission-supported laboratory work both before launch and post-launch has dropped precipitously. Coupled with greater demand and less supply from R&A, laboratory facilities and level of effort in those facilities is dropping, resulting in a piecemeal approach to funding laboratory work relevant to Ocean Worlds.

Hibbitts et al. White Paper

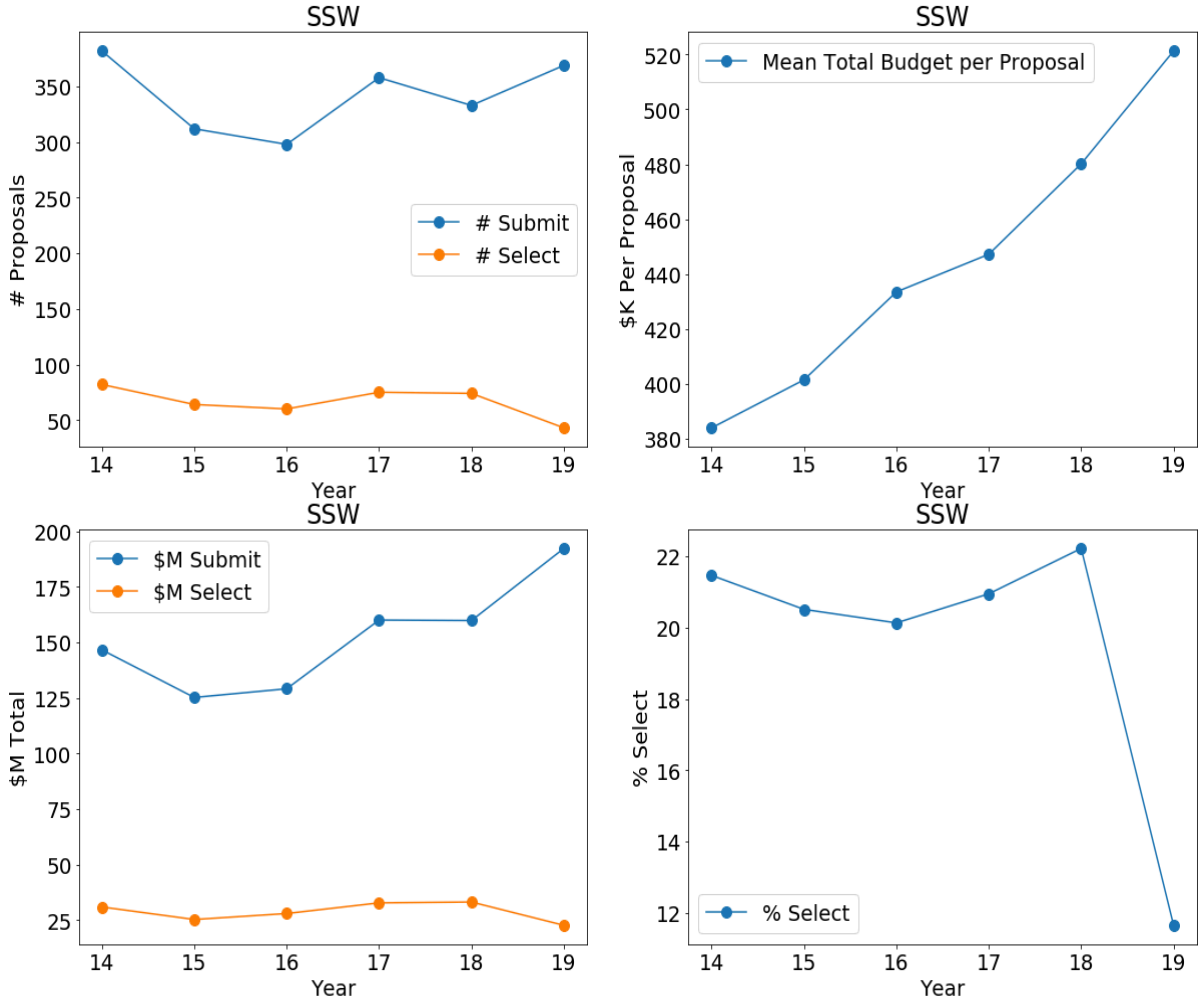
State of Cassini DAP Since 2008



The average proposal budget has increased by more than 40% since 2010, but the funding allocation to that program has shown large variations from one year to another.

Source: [Throop, presentation to the Outer Planet Assessment Group, September 2020]).
Note that these are raw budget data not adjusted for inflation.

State of SSW Program Since 2008



The average proposal size has increased by 37% between 2014 and 2019 (vs. 8% inflation). However, the budget has remained about constant while the total budget request for SSW has gone up from $125M to $192M (53%). As a result, the 2019 selection has been less than 12%. It was announced on September 2, 2020 that the ROSES 2020 SSW budget for new awards would be cut from $10M to $7.5M.

Source: Throop, presentation to the Outer Planet Assessment Group, September 2020).
Note that these are raw budget data not adjusted for inflation.

WHAT IS A SUSTAINABLE R&A FUNDING LEVEL?

Vision and Voyages for Planetary Science in the Decade 2013-2022

"Over the 7 fiscal years 2003-2009, an average of 37 percent of the grant proposals submitted to an average of 18 or 19 programs in NASA's Planetary Science Division have been supported. The success ratio is lower than desirable"

"The committee strongly encourage NASA to find ways (e.g., by merging related research programs and lengthening award periods) to increase average grant sizes and reduce the number of proposals that must be written, submitted, and reviewed by the community."

"NASA should periodically evaluate the strategic alignment and funding level of all its SRA programs to ensure they remain healthy and productive."

- A rate of 40% is not unreasonable given past decadal analyses and the significant expansion of targets and science that has occurred over just the past ten years
- Furthermore, the R&A budget should reflect the fact that the planetary field is growing and that with more missions come more data to analyze, and with improved technologies come more capabilities to analyze the data.
- **Thus, the Decadal Survey should recommend a funding level of $500M for FY23,** to grow 1.5% above inflation each year for the rest of the decade. This reflects both the need to achieve a more appropriate selection rate while also taking into consideration the exploding diversity of solar system exploration science that continues today.