

Forward Contamination of Ocean Worlds

A Broader Stakeholder Conversation

Brent Sherwood (JPL)

Adrian Ponce (JPL)

Michael Waltemathe (Ruhr-Universität Bochum)

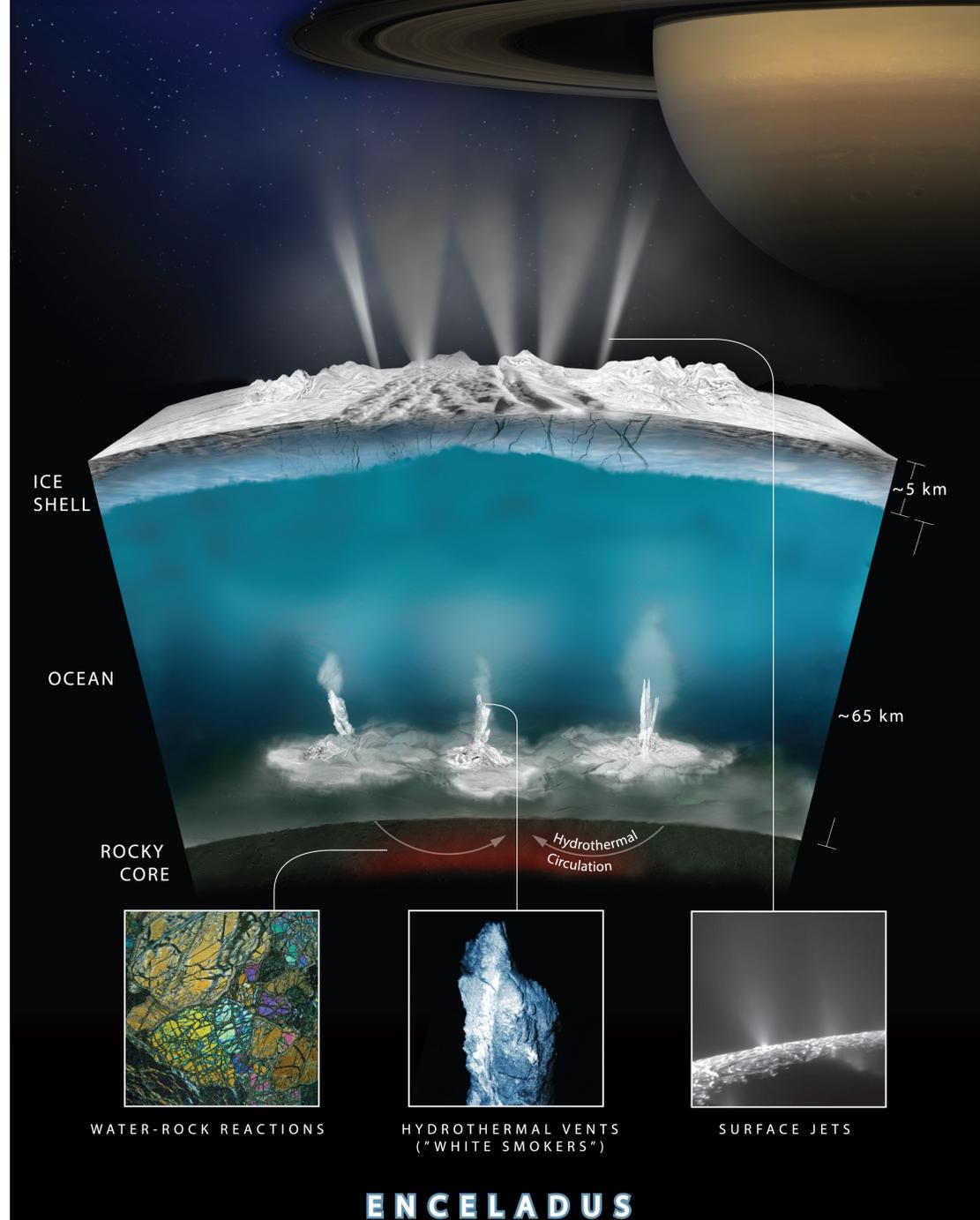
42nd COSPAR Assembly

Pasadena

16 July 2018



Jet Propulsion Laboratory
California Institute of Technology



Stakeholder discussion about forward contamination is becoming more urgent

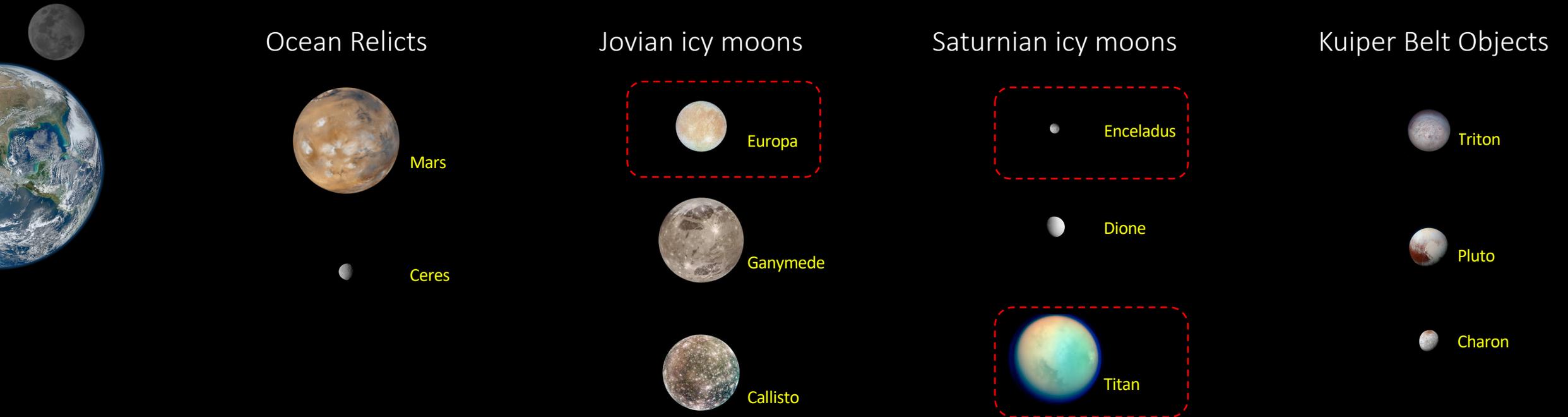
Increased probability of encountering alien ecosystems

Increased scientific and public interest in ocean-world exploration

The generations that would implement these missions, and live with the consequences, have not yet weighed in on fundamental issues:

1. Humankind's potential to contaminate these worlds
2. The implications of doing so
3. Acceptable ways of managing this risk

Originally just Mars...now, many ocean worlds



Today's requirement is simple and clear

For ocean worlds, limit to 10^{-4} the probability that any mission introduces a single viable Earth organism into a “potential habitat”

- Potential habitat = liquid water or warm ice
- Applies to all spacefaring enterprises
- Adopted by international consensus via COSPAR (Committee on Space Research, an International Non-Governmental Organization)
- Compliance enforceable through the issuance of launch licenses by states party to the 1967 Outer Space Treaty

Scientific motives dominate ethical dimension

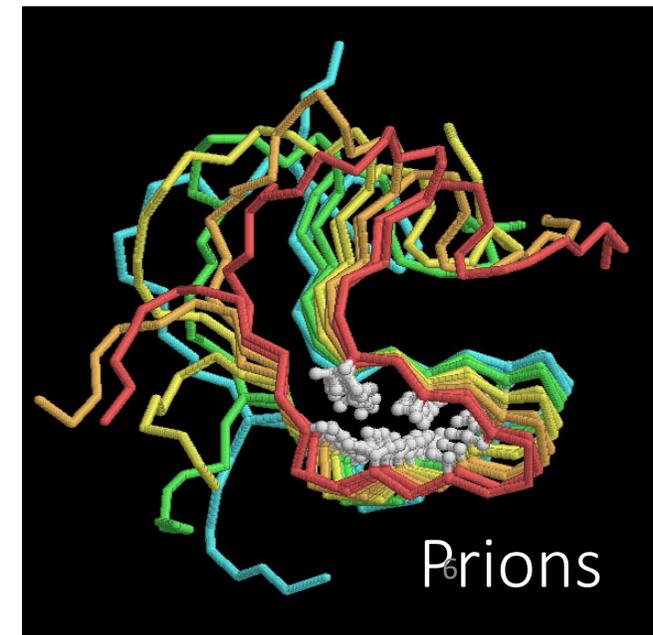
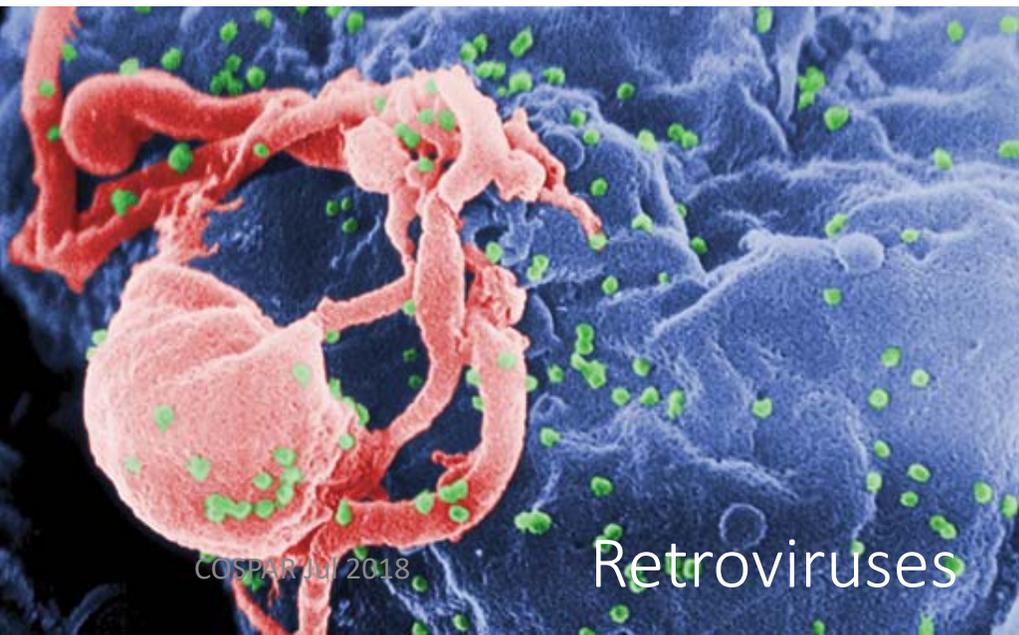
10^{-4} requirement dates from the 1960s

- Capability-based, but thought to envelope other considerations

Requirement has been refractory for a half century, despite significant changes in its context

- Scientific understanding of life
- Societal views of science

Life is more diverse and tenacious, yet more interdependent, than we used to think



Why is there an ethical dimension?

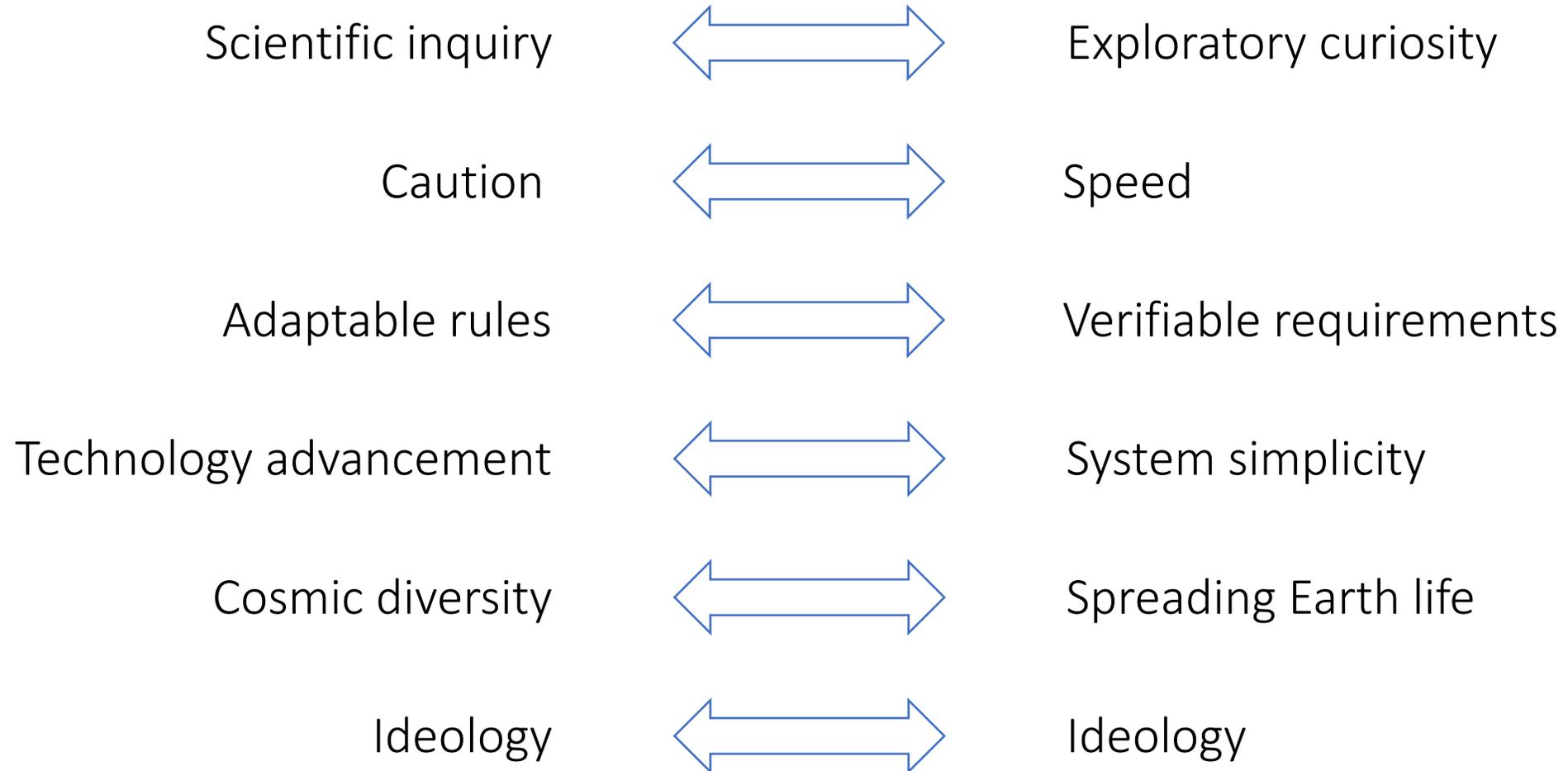
A decision becomes an ethical problem when at least two positive values are weighed against each other

- If no alternatives, then no ethical problem
- If no positive values, then no ethical problem

Forward planetary protection has diffuse positive values

- ✓ The value of research in an uncontaminated pristine environment
- A possible human obligation toward extraterrestrial life
- The value of untouched environments in themselves
- ✓ The value of minimizing cost and other obstacles to progress

Opposing positive values create ethical tension



Labile value perceptions – an ethical sliding scale

Case 1 – Non-habitable environment

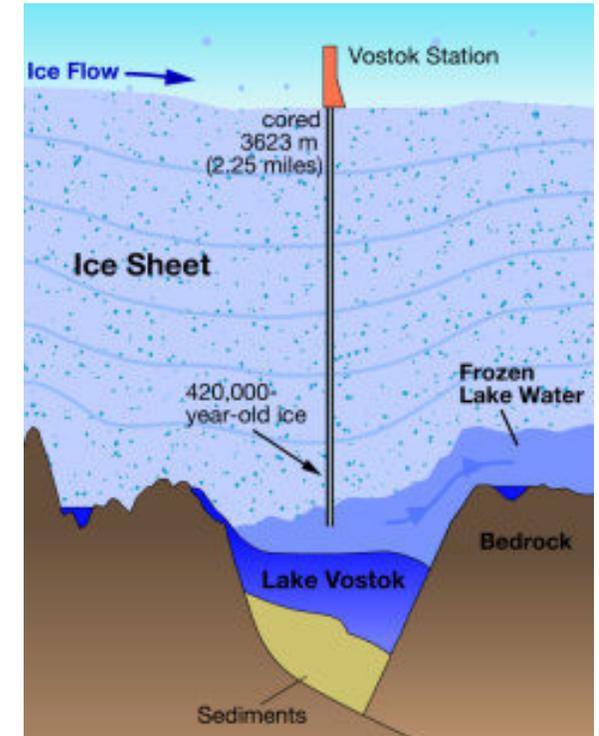
- Such environments are already being explored

Case 2 – Habitable and possibly inhabited

- At first, go slow – lesson from Lake Vostok
- Studying alien life – observing, culturing, experimenting
- Reassembling life – CRISPR/Cas
- Mixing, hybridizing life from different ocean worlds
- Terrestrial-alien chimeric life

Case 3 – Habitable but uninhabited

- Expand the reach of terrestrial life?



Are there lessons from the Risk Management field?

Hazard = “a threat to ~~people~~ and the things they value”

R.W. Kates & J.X. Kasperson, 1983.
Comparative risk analysis of technological hazards. *Proc. Nat. Acad. Sci. USA* Vol 80, pp.7027-7038 (cited in Pidgeon et al., 1992).

Scientific integrity

Avoid destroying or irreversibly complicating the opportunity for future scientific analysis of a potential habitat

A soft cost

Moral obligation

Avoid interfering with a living system or habitat upon first contact

A “Prime Directive”?

The second branch is not amenable to scientific reasoning

Societal consideration of risk is a social science

- Low-Probability, High-Consequence risks are part technical, part “psycho-social”
- Quantitative risk-assessment tools are inherently limited
- People judge very low or very high numbers very poorly
- Dominant driver is “distrust of the professional expert, and, by extension, distrust of the process of identifying and dealing with risks”

N. Pidgeon, C. Hood, D. Jones, B. Turner, R. Gibson, 1992. Risk Perception, in *Risk: Analysis, Perception & Management*, ISBN 0 85403 4676. Royal Society

D.M. Kammen, A.I. Schlyakhter, R. Wilson, 1994. What is the risk of the impossible? *Technology: J. of the Franklin Inst.* Vol 331A, pp.97-116.

Successful precedents exist for societal resolution of such risks

How does 10^{-4} compare to other small numbers?

1 in 15. Getting admitted to Yale

<http://www.businessinsider.com/ivy-league-harvard-yale-princeton-acceptance-rates-class-of-2021-2017-3>

1 in 20. Lifetime death from injury

1 in 133. Odds of getting on RuPaul's Drag Race

<http://www.iii.org/fact-statistic/mortality-risk>

1 in 606. Lifetime death from vehicular injury

<http://wonderopolis.org/wonder/what-are-your-odds-of-winning-the-lottery>

1 in 1615. Yearly death from an injury

1 in 9737. Lifetime death from aircraft accident

1 in 10,000. Max allowable, introducing one Earth organism into a potential habitat

1 in 11,207. Yearly death from assault with a gun (in the USA)

1 in 141,571. Yearly death from falling down stairs

1 in 13,744,732. Yearly death from lightning

1 in 13,983,816. Winning 6-number lottery from pool of 49 numbers

Approach demonstrated by particle-physics community

1. Information campaign socializes current state and future options
 - The types of exploration we can now undertake
 - Implications for science and for potential alien life
 - How we manage the risk today
2. Open, inclusive international conversation with wide stakeholder reach allows deterministic policy
 - Scientists + Ethicists + Managers + Citizens
 - Thought leaders from all generations

0 of 9 recommendations made by a 2010 Princeton Workshop have been followed...

1. An expanded overall framework for COSPAR Planetary Protection policy/policies is needed to address other forms of ‘harmful contamination’ than currently addressed
2. COSPAR should **maintain the current policy**...under an expanded framework...for overall protection policy
3. COSPAR should add a separate and parallel policy to provide guidance on requirements/best practices for protection of...nonlife-related aspects

J. Rummel, M. Race. Ethical Considerations for Planetary Protection in Space Exploration: A Workshop. *Astrobiology*, Oct 2012, DOI: 10.1089/ast.2012.0891

...despite a detailed template for action

4. COSPAR should consider that the **appropriate protection of potential indigenous extraterrestrial life** shall include avoiding the harmful contamination of any habitable environment...
5. In the COSPAR PREAMBLE on planetary protection, add wording (italics) to acknowledge the values of life...[including that] *life, including extra-terrestrial life, has special ethical status and deserves appropriate respect because it has both intrinsic and instrumental values...*
6. ...there should be **continued study over the next several years** of various useful structures and frameworks that could incorporate scientific input on one end, and enforcement on the other

Yet COSPAR has assembled twice since 2010...

7. COSPAR should **set up a group (or future workshop) to further explore the ethical values** (e.g., intrinsic and instrumental) that apply to life, non-life, and environments...in order to provide guidance for balancing the different interests. Additional details on what this workshop comprises will be **developed at future COSPAR Assemblies**.
8. COSPAR should elaborate on management guidelines in interaction with organizations such as IISL and others, to **establish a framework for environmental stewardship on celestial bodies** for submittal to the UN COPUOS for UN General Assembly consideration.

...and now, here we are in 2018

9. COSPAR should encourage its members and the associated states to **undertake public dialogue and engagement efforts** at the national and/or regional level concerning ethics in space exploration, with the ultimate purpose of having public sentiment (including public perception) integrated appropriately into COSPAR policy deliberations. In addition, COSPAR should ask the PPP and PEX groups to **hold a workshop on public engagement, consultation, and participation in policy-making** in order to inform members about the premises, principles, and purposes of public engagement activities and best practices.