EXPLORING THE POTENTIAL HABITABILITY OF EUROPA: SCIENCE OBJECTIVES FOR THE EUROPA CLIPPER MISSION CONCEPT. D. Senske[1], L. Prockter[2], R. Pappalardo[1], B. Paczkowski[1], S. Vance[1], B. Goldstein[1], T. Magner[2], and B. Cooke1[1], [1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, [2]Johns Hopkins University Applied Physics Laboratory, Laurel, MD, 20723.

Introduction: A cornerstone of the Planetary Decadal Survey, "*Visions and Voyages*" [1], is to understand the processes that lead to potential habitability across the solar system. Fundamental to this goal is evaluating the astrobiological significance of the icy outer planet satellites. It is in this context that Europa has been placed at the forefront of outer planet exploration targets [1].

Insight into Europa's potential habitability requires understanding the three "ingredients" for life: water, chemistry, and energy. Europa may have all three of these ingredients in the form of: (1) an extensive salt-water ocean beneath an ice shell that is geodynamically active and relatively thin (several kilometers to several tens of kilometers thick); (2) essential chemical elements derived from the primordial chondritic composition of the Jovian protoplanetary disk, plus delivery by asteroids and comets over time; and (3) a source of chemical energy for life created by the combination of irradiation of its surface and tidal heating of its interior. But the processes that shaping Europa's ice shell, and the exchange processes between the surface and ocean, are not clearly understood. Even the existence of a subsurface ocean, while generally accepted, is not proven.

A NASA chartered Europa Science Definition Team (SDT) formulated the goal for future Europa exploration as: "Explore Europa to investigate its habitability." The SDT (disbanded in June of 2014) considered the objectives for a mission in Jupiter orbit, named the Europa Clipper, that would make multiple-flybys of Europa based on the current hypotheses regarding the satellite's potential for being habitable:
(1) *Ocean and Ice Shell*: *:* Characterize the ice shell and any subsurface water, including their heterogeneity, ocean properties, and the nature of surface-ice-ocean exchange;
(2) *Composition*: Understand the habitability of Europa's ocean through composition and chemistry;
(3) *Geology*: Understand the formation of surface features, including sites of recent or current activity, and characterize high science interest localities.

The Europa SDT also considered implications of the Hubble Space Telescope detection of a possible plume at Europa [2].

Science achieved by the Europa Clipper would provide global and regional characterization of the satellite. It is anticipated that a next logical step to address scientific questions regarding the habitability and composition of this icy world's subcrustal ocean would be to land a spacecraft capable of *in situ* sampling and analysis. From a recent study of a lander concept [3], it became clear that additional information is needed regarding surface characteristics and properties to robustly architect a low-risk lander concept. To maximize success of a potential future landed mission high fidelity surface reconnaissance is essential.

The objectives of reconnaissance for the Europa Clipper are two-fold:
(1) *Site Characterization*: Assess the distribution of surface hazards, the load-bearing capacity of the surface, the structure of the subsurface, and the regolith thickness of at least 15 sites of interest;
(2) *Science Value*: Assess the composition of surface materials, the geologic context of the surface, the potential for geologic activity, the proximity of near surface water, and the potential for active upwelling of ocean material of at least 15 sites of interest.

The Clipper Mission: Based on the SDT defined science and reconnaissance goals and objectives, a Jet Propulsion Laboratory-Applied Physics Laboratory Europa technical team has devised a flight system and mission design that can accommodate a capable science payload responsive to these objectives. A mission design that incorporates 45 close flybys of Europa has been developed to achieve globally distributed regional surface coverage. The overall mission architecture is optimized to achieve science, while minimizing radiation exposure inherent in the Jupiter system.

Conclusions: A Jupiter-orbiting spacecraft that makes many flybys of Europa would provide an excellent platform from which to conduct measurements to investigate Europa's ocean and ice shell, composition, and geology, and thus the potential ingredients for life. Development of the Europa Clipper mission concept is ongoing, with current studies focusing on spacecraft requirements development and design refinements. We will provide an update on status of the science and reconnaissance development of this mission concept.

References: [1] Space Studies Board, (2011) The National Academies Press, Washington, DC. [2] Roth, L. *et al.*, (2014) *Science*, 343, 171-174. [3] Europa Study Team, (2012) JPL Internal Document D-71990.