Appendix 1. Survey questionnaire

The questionnaires only differed in the introductory text; questions were identical.

Introductory text for First Survey

Astrobiology community survey on Solar System targets

This short questionnaire is the first of two exploring what the community thinks are interesting targets for missions to search for life. It is not associated with any specific mission, institution or programme. I am asking those with knowledge of astrobiology how likely they think it is that different solar system bodies will be found to harbour indigenous life. By 'indigenous' I mean life that flourishes on the body for millennia, not transient contamination by meteorites or by spacecraft. This can include life in rocks, internal oceans etc., not just on the surface. This is the first of two questionnaires I will be sending out, the second equally short one will come in a few weeks. Thanks for your help. William Bains (bains@williambains.co.uk)

Introductory text for second survey

Astrobiology community survey on Solar System targets

This short questionnaire is the second of two exploring what the community thinks are interesting targets for missions to search for life. Since my first survey in June, new data has been published suggesting that phosphine, a biosignature gas (indicator of the presence of life) is present in the atmosphere of Venus. [See https://cutt.ly/yf2a50j and https://cutt.ly/Pf2sq9s for papers on the discovery]. On Earth phosphine is solely made by life [See https://cutt.ly/Nf2sw3n for references]. In light of this new data, I am asking again how likely astrobiologists think it is that different solar system bodies will be found to harbour indigenous life. By 'indigenous' I mean life that flourishes on the body for millennia, not transient contamination by meteorites or by spacecraft. This can include life in rocks, internal oceans, in the clouds etc., not just on the surface. Thanks for your help. William Bains (bains@williambains.co.uk)

Questions

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What do you think the chances are that indigenous life exists on (or in) the following (listed alphabetically) *

	0%	1%	2%	3-5%	5-10%	10-20%	20-35%	35-50%	>50%
Enceladus	○	○	○	○	○	○	○	○	○
Europa	○	○	○	○	○	○	○	○	○
Mars	○	○	○	○	○	○	○	○	○
Titan	○	○	○	○	○	○	○	○	○
Venus	○	○	○	○	○	○	○	○	○

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If you had $1bn to spend on one mission to one body specifically to search for life, in addition to any current or planned missions that you know of, which body would you target? *

	Enceladus	Europa	Mars	Titan	Venus	None (waste of $1bn)
Row 1	○	○	○	○	○	○

What scientific discipline best describes your main area of expertise? (You can tick more than one) *

- [ ] Mathematics
- [ ] Physics
- [ ] Astronomy
- [ ] Geology
- [ ] Atmospheric sciences
- [ ] Chemistry
- [ ] Biochemistry
- [ ] Microbiology
- [ ] Cell / molecular / structural biology
- [ ] Other biology
- [ ] Instrumentation / engineering

If you would like to get a summary of the results, please fill in an e mail below (not compulsory, and e-mails will not be shared with anyone outside this survey. Please make sure that bains@williambains.co.uk is flagged as 'not junk' by your e-mail program for a reply)

Your answer

Appendix 2. Fitting a continuous curve to the binned probability values

To use our survey results as an estimate of p(L) for Bayesian calculation, we needed to find a curve for the probability density function of the prior probability of life *p(L)* , (f(*p(L)*), that a) was a smooth, continuous curve, b) did not have negative values (as negative probability is not meaningful) and c) gave probability values for the bins used for the survey matching those of the results for Venus in the first survey. It was clear by inspection that the community estimates of life on solar system bodies did not fit a single simple distribution such as a Gaussian or Poisson distribution. It is reasonable to suppose that there are different communities within astrobiology with their own views on the likelihood of life on other worlds (The presence of a Fans of Icy Moons group was one such sub-community that the data shows). We therefore matched the observed distribution of f(*p(L)*), to the sum of four Gaussian functions, the parameters of which were optimized using a simulated annealing algorithm (Kirkpatrick et al. 1983). Such matching gives a good match for all the survey results. Figure 1 shows the matching of the final function to the observed data for Venus, and Table 1 gives the parameters and goodness of fit for all five Solar System bodies.

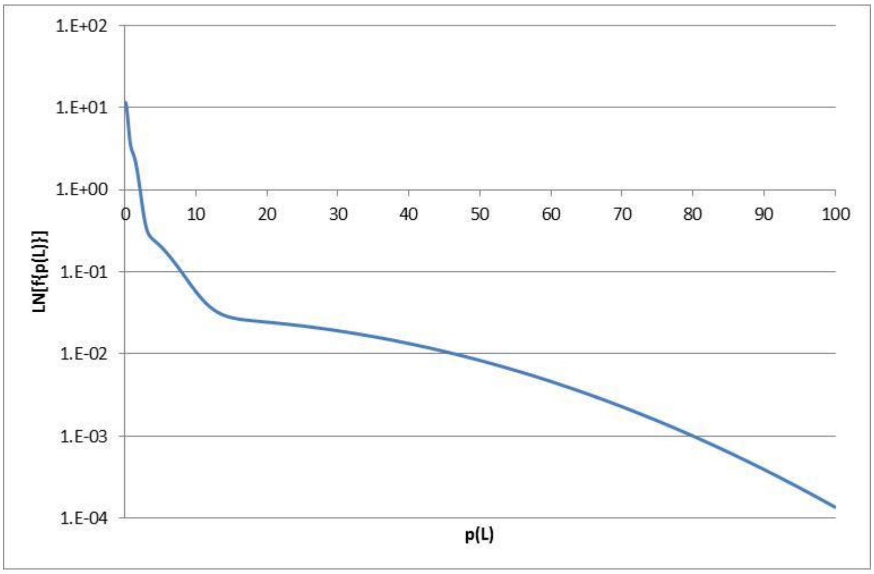
Polynomial fitting was also tried with CurveExpert, but the results were not stable to small changes in starting conditions and so this approach was abandoned. We emphasise that this exercise was solely to transform a discrete distribution that was binned to unequal size bins to a continuous function that could be manipulated using Bayesian math. It is not meant to have any further significance.

	A	B	C	D	E	F	G	H	I	J	K	L	RMS error counts (out of 121)
Enceladus	0.03433	0.02093	-0.01874	0.83234	0.14939	-0.20697	0.07917	0.03709	-1.51028	0.60422	1.35947	-1.49003	0.12285
Europa	0.97128	0.45721	-1.94387	1.35598	1.15117	-1.45933	0.69562	0.39589	-7.84324	0.27	0.15	-7.55	0.30166
Mars	3.05836	1.96192	-1.65857	1.20404	0.51118	-1.76635	0.56187	0.49822	-9.56756	0.52125	0.28850	-14.6353	0.05708
Titan	4.67742	0.54984	0.30484	0.36703	0.76900	-15.5683	0.50645	0.11406	-0.17068	0.1	0.1	-4.9	0.97911
Venus	2.63772	0.88421	-0.73633	9.80942	2.17677	-0.02384	0.29331	0.16098	-0.09753	0.02830	0.02409	-0.10010	0.73100

Table 1: Curve matching parameters

Coefficients in the equation $f[p(L)] = A \cdot e^{-(B.p(L)+C)^2} + D \cdot e^{-(E.p(L)+F)^2} + G \cdot e^{-(H.p(L)+I)^2} + J \cdot e^{-(K.p(L)+L)^2}$, and RMS matching of that equation to the survey data from the first survey.

A.



B.

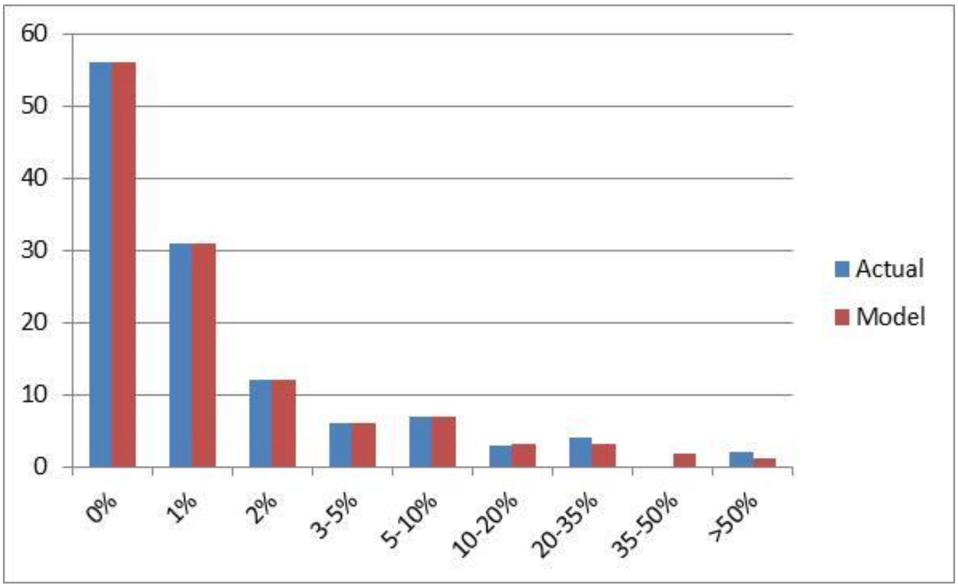


Figure 1: Polynomial curve matching results

A. Probability density function for LN(f(p(L))), optimized to fit the observed results from the first survey. Y axis: LN(f(p(L))), X axis: p(L). B. Prediction of the number of responses in each of 9 'bins' of p(L) predicted from the polynomial plotted in Figure 1A and with coefficients listed in Table 1 for Venus.