Near-Earth-object survey progress and population of small near-Earth asteroids

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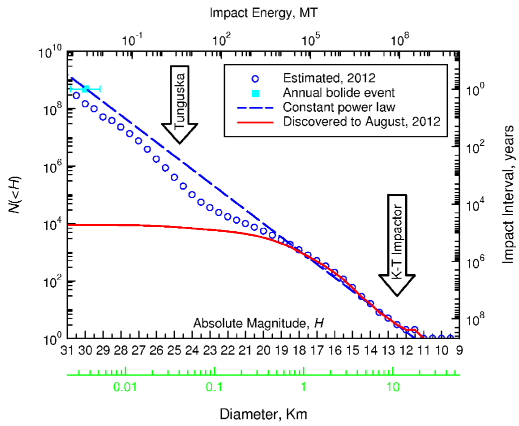
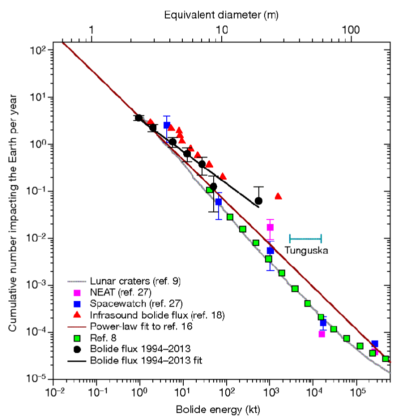
Estimating the total population vs. size of NEAs and the completion of surveys is the same thing since the total population is just the number discovered divided by the estimated completion. I review the method of completion estimation based on ratio of re-detected objects to total detections (known plus new discoveries). The method is quite general and can be used for population estimations of all sorts, from wildlife to various classes of solar system bodies. Since 2001, I have been making estimates of population and survey progress approximately every two years. Plotted below, left, is my latest estimate, including NEA discoveries up to August, 2012. I plan to present an update at the meeting.

All asteroids of a given size are not equally easy to detect because of specific orbital geometries. Thus a model of the orbital distribution is necessary, and computer simulations using those orbits need to establish the relation between the raw re-detection ratio and the actual completion fraction. This can be done for any sub-group population, allowing to estimate the population of a subgroup and the expected current completion. Once a reliable survey computer model has been developed and ”calibrated” with respect to actual survey re-detections versus size, it can be extrapolated to smaller sizes to estimate completion even at very small size where re-detections are rare or even zero. I have recently investigated the subgroup of extremely low encounter velocity NEAs, the class of interest for the Asteroid Redirect Mission (ARM), recently proposed by NASA. I found that asteroids of diameter ~ 10 m with encounter velocity with the Earth lower than 2.5 km/sec are detected by current surveys nearly 1,000 times more efficiently than the general background of NEAs of that size. Thus the current completion of these slow relative velocity objects may be around 1%, compared to 10^{-6} for that size objects of the general velocity distribution. Current surveys are nowhere near complete, but there may be fewer such objects than have been suggested. This conclusion is reinforced by the fact that at least a couple such discovered objects are known to be not real asteroids but spent rocket bodies in heliocentric orbit, of which there are only of the order of a hundred.

Brown et al. (*Nature* **503**, 238–241, 2013, below right, green squares are a re-plot of my blue circles on left plot) recently suggested that the population of small NEAs in the size range from roughly 5 to 50 meters in diameter may have been substantially under-estimated. To be sure, the greatest uncertainty in population estimates is in that range, since there are very few bolide events to use for estimation, and the surveys are extremely incomplete in that size range, so a factor of 3 or so discrepancy is not significant. However, the population estimated from surveys carried still smaller, where the bolide frequency becomes more secure, disagrees from the bolide estimate by even less than a factor of 3 and in fact intersects at about 3 m diameter. On the other hand, the shallow-sloping size-frequency distribution derived from the sparse large bolide data diverges badly from the survey estimates, in sizes where the survey estimates become ever-increasingly reliable, even by 100–200 m diameter. It appears that the bolide data provides a good “anchor” of the population in the size range up to about 5 m diameter, but above that one might do better just connecting that population with a straight line (on a log-log plot) with the survey-determined population at larger size, 50-100 m diameter or so.





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