Near Earth Object Observations (NEOO) Program

Presentation to Committee on Peaceful Uses of Outer Space Science & Technical Subcommittee

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Scientific Objective: Discover 90% of NEOs larger than 1 kilometer in size within 10 years (1998 – 2008)
Current budget - ~ $4M per year
**Terminology**

- **“Near Earth Objects (NEOs)”** - any small body (comet or asteroid) passing within 1.3 astronomical unit (au) of the Sun
  - 1 au is the distance from Earth to Sun = ~ 150 million kilometers (km)
  - NEOs are predicted to pass within ~ 48 million km of Earth’s orbit
  - e.g. any small body passing between orbits of Venus to Mars
  - Population of:
    - Near Earth Asteroids (NEAs)
    - Near Earth Comets (NECs) – also called Earth Approaching Comets (EACs)
      - 64 currently known

- **“Potentially Hazardous Objects (PHOs)”** – a small body that has potential risk of impacting the Earth at some point in the future
  - NEOs passing within 0.05 au of Earth’s orbit
    - ~ 8 million km = 20 times the distance to the Moon
  - Appears to be almost 20% of all NEOs discovered
Empirical data collected to date shows a $10^2$ power law relationship to size for NEO populations.

“Straight blue line”: 

\[
\log[N(<H)] = -3.2H + 8.8 
\]
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“Straight blue line”:

For 1 km objects:

$N(H<18.0) = 1420$

$N(H<17.75) = 1090$
Empirical data collected to date shows a $10^2$ power law relationship to size for NEO populations.

“Straight blue line”:

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For 100 m objects:
- $N(H<22.0) \sim 100,000$
Discovery Statistics

Chart 1: Cumulative Large NEO Discoveries

- Goal: 980
- Estimated: 1090 ± 100
- 767* as of 02/17/07

*Includes 64 NECs
Chart 2: Large NEO Discovery Rate
NASA Funded NEO Search Projects
Lincoln Near Earth Asteroid Research (LINEAR)

- **Sponsor Institute:** Massachusetts Institute of Technology / Lincoln Laboratory (via US Air Force)
- **Location:** White Sands, NM
- **Instrumentation:**
  - 2 Telescopes
  - 1 meter (AF GEODSS-prototype)
  - Detector
    - CCD 2560 x 1960 pixels
    - FOV = 2 square degrees
    - Vm lim = ~20.0
- **Discoveries since 1998:**
  - NEOs Larger than 1 km = 303
  - NEOs Smaller than 1 km = 1596
  - Total # of Objects > 220,000
Near Earth Asteroid Tracker (NEAT)

- **Sponsor Institute:**
  Jet Propulsion Laboratory
- **Location:** Palomar, CA
- **Instrumentation:**
  - Telescope
    - Palomar 1.2 meter
  - Detector
    - 3 4080 x 4080 pixel CCDs
    - FOV = 3.75 square degrees
    - Vm lim = ~20.5
- **Discoveries since 1998:**
  - NEOs Larger than 1 km = 58
  - NEOs Smaller than 1 km = 355
  - Total # of Objects > 6,000
Spacewatch

• **Sponsor Institute:**
  Lunar & Planetary Laboratory University of Arizona

• **Location:** Kitt Peak, AZ

• **Instrumentation:**
  - Telescopes (2) Detector (CCD) Vm lim
    - 0.9 meter 4 4608 x 2048 21.7
    - 1.8 meter 2048 x 2048 23.3

• **Discoveries since 1998:**
  - NEOs Larger than 1 km = 20
  - NEOs Smaller than 1 km = 414
  - Total # of Objects =
Lowell Observatory Near Earth Object Search (LONEOS)

- Sponsor Institute: Lowell Observatory
- Location: Flagstaff, AZ
- Instrumentation:
  - Telescope
    - 0.6 meter
  - Detector
    - 2048 x 4096 CCD
    - FOV = 2.9 x 2.9 degrees
    - Vm lim = 19.3
- Discoveries since 1998:
  - NEOs Larger than 1 km = 40
  - NEOs Smaller than 1 km = 241
  - Total # of Objects > 30,000
Catalina Sky Survey

- Sponsor Institute: Lunar & Planetary Laboratory University of Arizona
- Location: Mt Lemmon, AZ Siding Spring, AUS
- Instrumentation:
  - Telescopes (3)
    - 0.7 meter
    - 0.5 meter
    - 1.5 meter (follow-up)
  - Detectors
    - 4K x 4K CCD
    - FOV 1.2 square degrees
    - Vm lim $\sim$ 20.0
- Discoveries since 1998:
  - NEOs Larger than 1 km = 67
  - NEOs Smaller than 1 km = 803
  - Total # of Objects > 10,000
• **Minor Planet Center (MPC)**
  – Smithsonian Astrophysical Observatory, Cambridge, MA
  • Dr Brian Marsden, Director Emeritus
  • Dr Tim Spahr, Acting Director
  – Worldwide observation coordination and correlation, initial orbit determination
  http://cfa-www.harvard.edu/iau/mpc

• **Near Earth Object Program Office**
  – Jet Propulsion Laboratory, Pasadena, CA
  • Dr Donald Yeomans, Program Manager
  – Precision orbit determination and hazard prediction
  http://neo.jpl.nasa.gov
Radar Studies

• Observations on the limited accessible objects
  – 10 to 15 NEOs/year from Goldstone and Arecibo
  – Important for timely precise orbit determination
  – Shape modeling with sufficient signal strength
Predicted Close Approach of 2004 MN4 “Apophis” (an ~320m Object) on April 13, 2029

So far, four other PHOs of significant size pass within lunar orbit in next 150 years.
The Congress declares that the general welfare and security of the United States require that the unique competence of the National Aeronautics and Space Administration be directed to detecting, tracking, cataloguing, and characterizing near-Earth asteroids and comets in order to provide warning and mitigation of the potential hazard of such near-Earth objects to the Earth.

The Administrator shall plan, develop, and implement a Near-Earth Object Survey program to detect, track, catalogue, and characterize the physical characteristics of near-Earth objects equal to or greater than 140 meters in diameter in order to assess the threat of such near-Earth objects to the Earth. It shall be the goal of the Survey program to achieve 90 percent completion of its near-Earth object catalogue (based on statistically predicted populations of near-Earth objects) within 15 years after the date of enactment of this Act.

The Administrator shall transmit to Congress not later than 1 year after the date of enactment of this Act an initial report that provides the following:

(A) An analysis of possible alternatives that NASA may employ to carry out the Survey program, including ground-based and space-based alternatives with technical descriptions.

(B) A recommended option and proposed budget to carry out the Survey program pursuant to the recommended option.

(C) Analysis of possible alternatives that NASA could employ to divert an object on a likely collision course with Earth.
Studied existing, planned, proposed and conceptual systems to perform expanded survey
- Ground-based and space-based

Findings:
- No single envisioned system completely accomplishes goal
- Combined architecture of planned ground-based survey telescopes coupled with an additional dedicated asset could achieve goal

Release of report to Congress is imminent
Areas for Potential International Cooperation

- Additional search assets, particularly in southern hemisphere
- Update and additional support to Minor Planet Center
  - Aging computer systems and software
  - Funding of additional personnel for future efforts
- Development of international protocol for objects on close approach or potential impact trajectories
  - Exchange of observations and orbit determination data
  - Dissemination of verified information to world governments