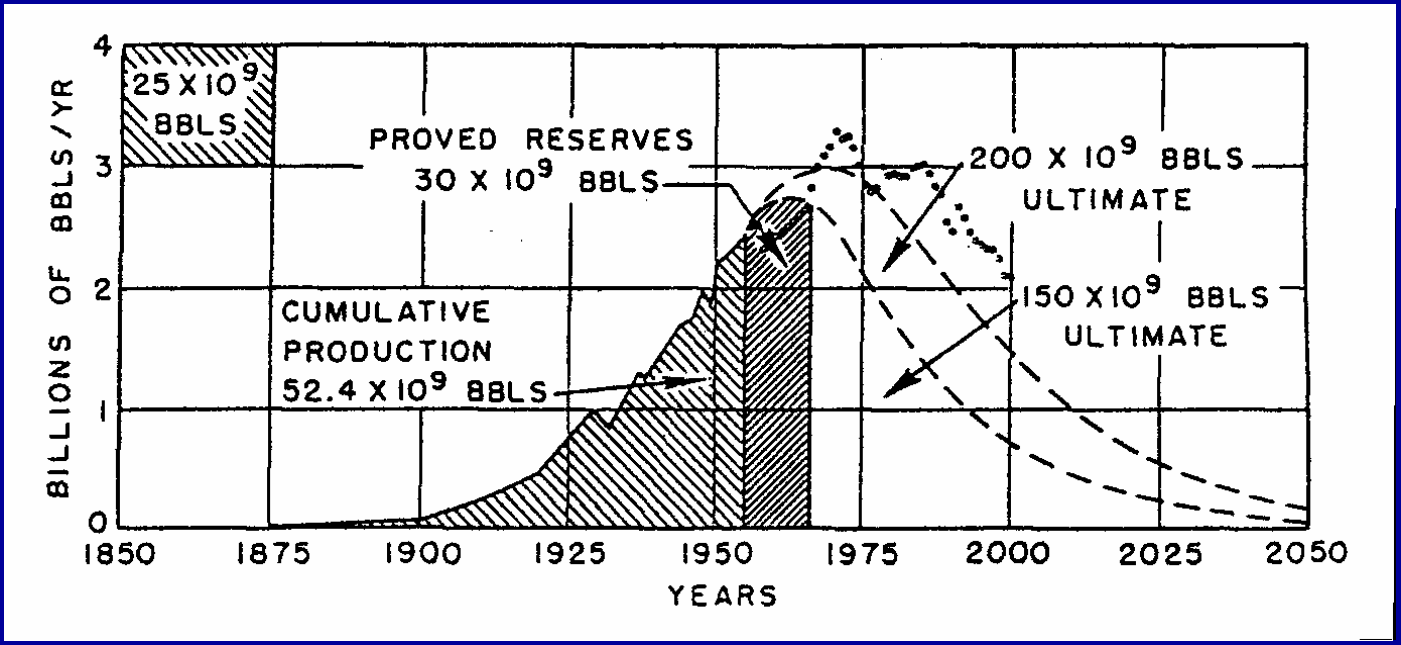
Probability and prediction

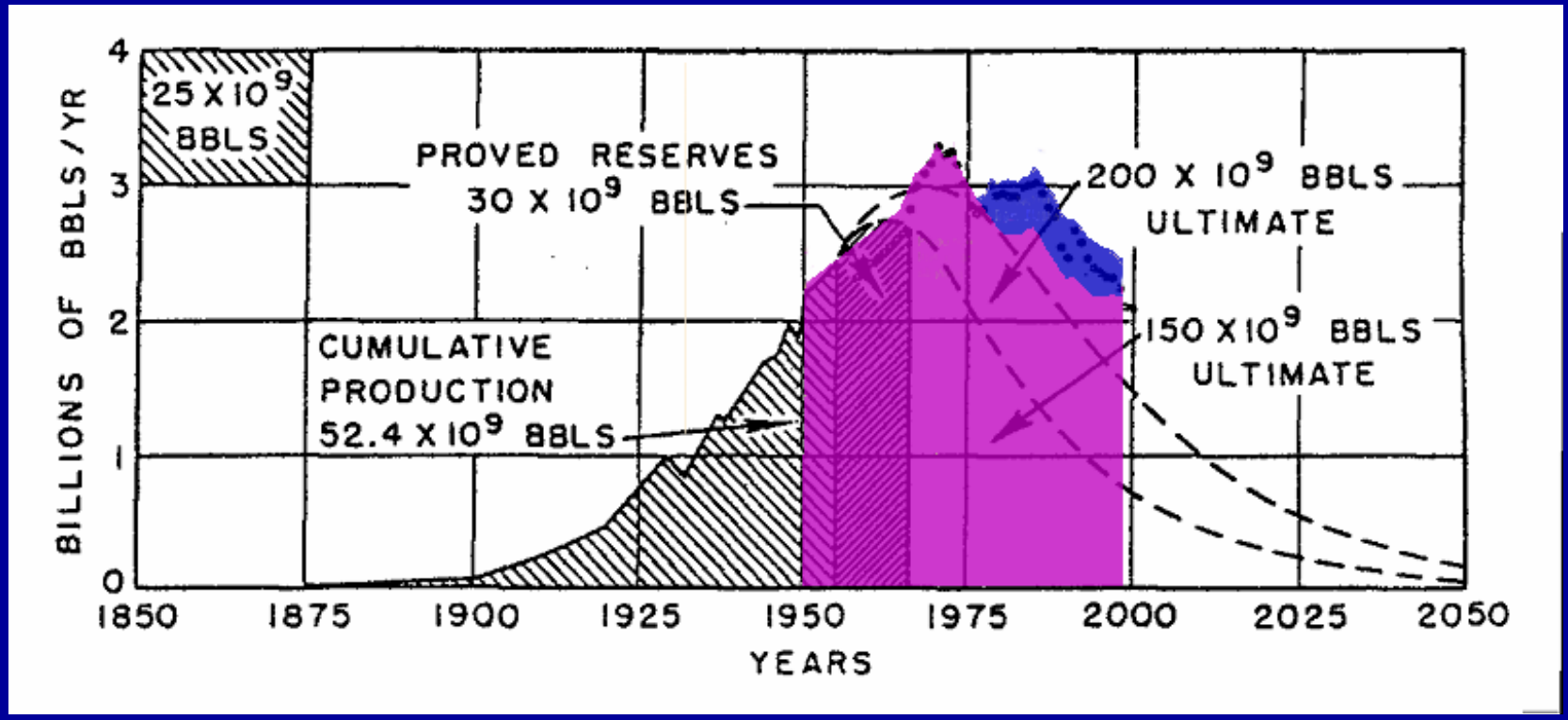
- How can we treat predictions of future shortages scientifically?
- What obstacles are there?
- Does it help to ask the question differently?

Hubbert's Peak

- M. King Hubbert, 1956:
  - Oil production in continental US will follow a bell-shaped curve
  - Peak production in 1970
  - Declining production thereafter



Prediction vs. Observation



Perception of probability and risk

- A certain town is served by two hospitals. In the larger hospital about 48 babies are born each day. In the smaller, about 16 babies are born each day.
- Overall, 50% of all babies are boys. However, the exact percentage varies from day to day. Sometimes more than 50% may be boys, sometimes less.
- For a period of one year, each hospital recorded the number of days on which more than 60% of the babies born were boys.
- Which hospital do you think recorded the most such days?
  - Larger
  - Smaller
  - The same

Experiment

- College students were asked the first question:
  - Larger hospital: 22%
  - Smaller hospital: 22%
  - The same: 56%
- Actual answer:
  - The smaller hospital:
    - Average: 8 boys
    - 60%: 10 boys (2 more than average)
    - For larger hospital it would be 29 vs. 24, or 5 more than average

General observations

- Many such tests demonstrate that people's intuitions are not well suited for understanding statistics
- Experts make many of the same errors as novices, although their errors tend to be smaller in magnitude.
- Some general sources of misunderstanding:
  - Tendency to generalize from small number of examples (belief in the law of small numbers)
  - Mistaking coincidence for cause and effect

Risk

- Imagine that the US is facing an outbreak of a new strain of flu that is expected to kill 6,000 people. Two alternate programs to combat this flu have been proposed
- Take the slip of paper I have handed out and consider which of the possibilities presented you would prefer.

From probability to risk

- Which of the following gambles would you prefer?
  - Gamble E
    - 25% chance to win $240
    - 75% chance to lose $760
  - Gamble F
    - 25% chance to win $250
    - 75% chance to lose $750

Another choice

Which of the following would you choose?

A. A sure gain of $240

B. A gamble:

- 25% chance to win $1000
- 75% chance to win nothing

And another

Which of the following would you choose?

C. A sure loss of $750

D. A gamble:

- 75% chance to lose $1000
- 25% chance to lose nothing

Let’s look at results

- First choice:
  - Who chose (1) (win $240, lose $760)?
  - Who chose (2) (win $250, lose $750)?
- Second and third choices:
  - (A) and (C)
  - (A) and (D)
  - (B) and (C)
  - (B) and (D)

Outcomes

- (A) and (C): Gain $240 + lose $750 = lose $510 for certain.
  - In other experiments, 11% chose this pair
- (A) and (D): Gain $240 + 75% chance to lose $1000 =
  - 25% chance to gain $240
  - 75% chance to lose $760
  - Same as gamble (E)
  - In other experiments, 73% chose this pair
- (B) and (C): 25% chance to gain $1000 + sure loss of $750:
  - 25% chance to gain $250
  - 75% chance to lose $750
  - Same as gamble (F)
  - In experiments, only 3% chose this pair
- (B) and (D):
  - Complicated gamble (four possible outcomes)
  - In other experiments, 13% chose this pair

Two forms of the question

- Imagine that the US is facing an outbreak of a new strain of flu that is expected to kill 6,000 people. Two alternate programs to combat this flu have been proposed: Assume that the exact scientific estimates of the consequences of the programs are as follows:
- Form 1:
  - If program “A” is adopted, exactly 2,000 people will be saved (72%)
  - If program “B” is adopted, there is a one-third probability that 6,000 people will be saved and a two-thirds probability that none will be saved. (28%)
- Form 2
  - If program “C” is adopted, exactly 4,000 people will die (22%)
  - If program “D” is adopted, there is a one-third probability that no one will die and a two-thirds probability that 6,000 people will die (78%)

Prospect Theory

- Loss and Gain are treated differently, asymmetrically.
- Problem:
  - Gambles don't add up
  - Thought: decreasing utility of money with wealth
- Additional Idea:
  - People are risk-averse. Uncomfortable with uncertainty
- Further Problem:
  - Even this picture doesn't give rational explanation of choices
- Prospect theory:
  - People are not risk-averse so much as loss-averse
  - When a problem can be stated two ways, people will choose differently if one way stresses gains, the other losses.

Implications for Oil & Water Futures

- Is the way we ask the question prone to bias?
- How can we use “objective” scientific information, or is the science unavoidably subjective itself?

Expert opinion

- Energy experts asked to estimate:
  1. World resources of high-grade uranium ore
  2. Future growth of electricity demand
  3. Cost and availability of photovoltaic solar energy cells
- All questions have objectively true answers
- Answers not known (trans-scientific)
- Experts opinions cluster:
  - High electricity demand, low resources of uranium, solar electricity difficult/expensive
  - Low electricity demand, plentiful uranium resources, solar electricity easy/cheap
  - Answers correlate with political support for nuclear “breeder reactors.”
- When are experts scientific? When are they just like the rest of us?