Comprehensive model for annoyance

In ideal world, with unlimited resources, research would develop comprehensive model for annoyance.

- Trust
- Fear
- Culture
- Visual
- Socio-economic status
- Age
- Health

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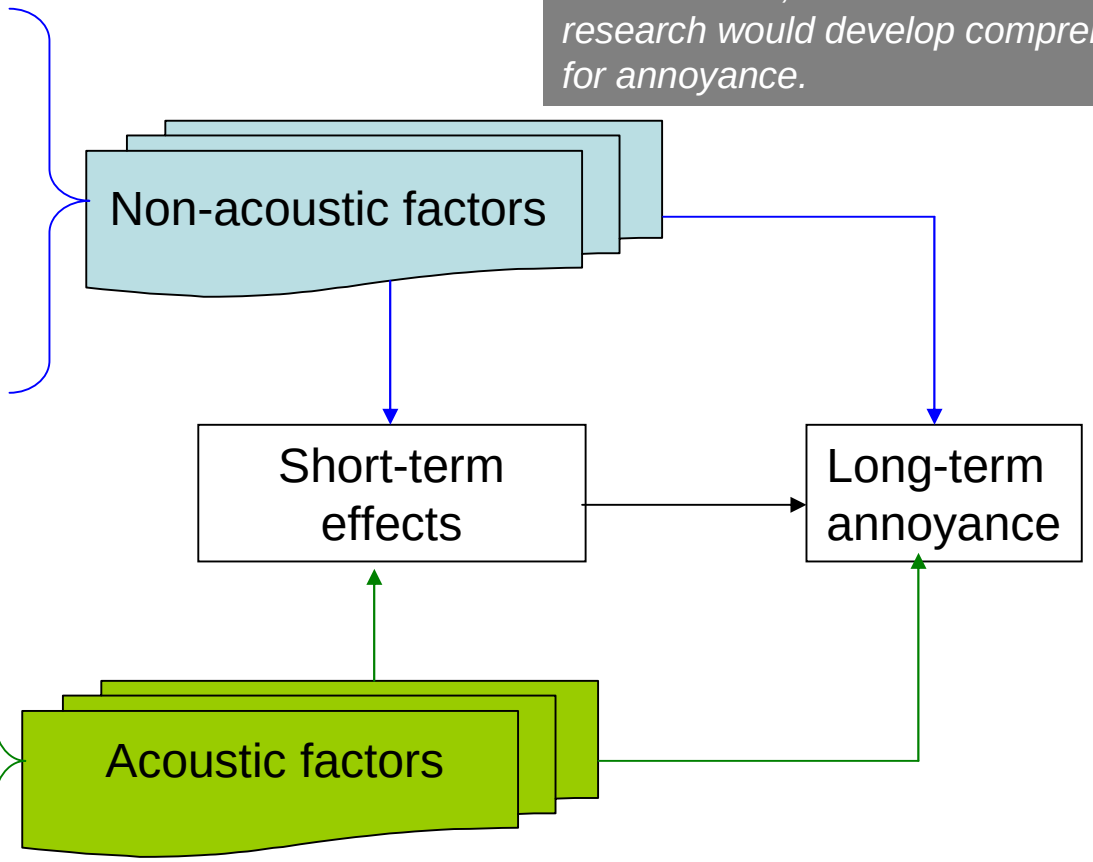


- Max sound level
- No. events
- Time of day
- Vibration/rattle
- Time-varying sound
- Frequency spectrum
- Roughness
- Duration of events
- Tonality
- Ambient sound levels
- Gradual vs. step change

…

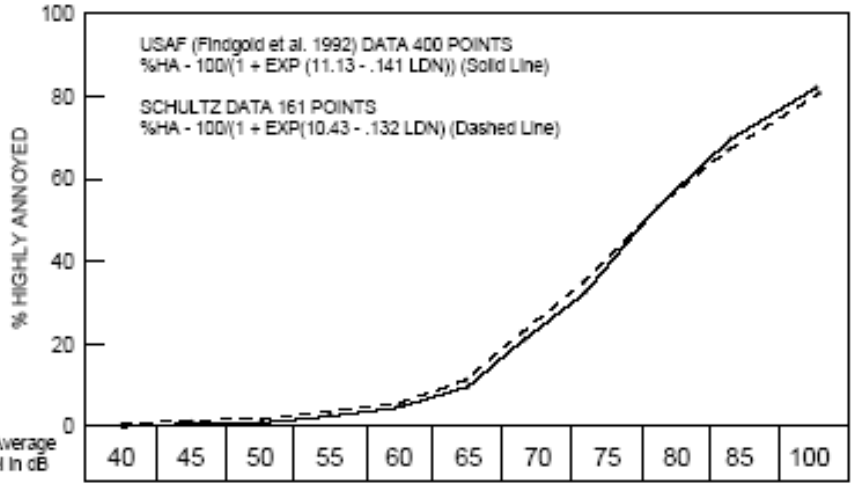
Simple model for annoyance

- Equivalent energy principle with time of day weighting
  - ❑No. events
  - ❑Time of day
  - ❑A-weighted sound level

DNL → Long-term annoyance

Assumptions and/or have sufficient evidence

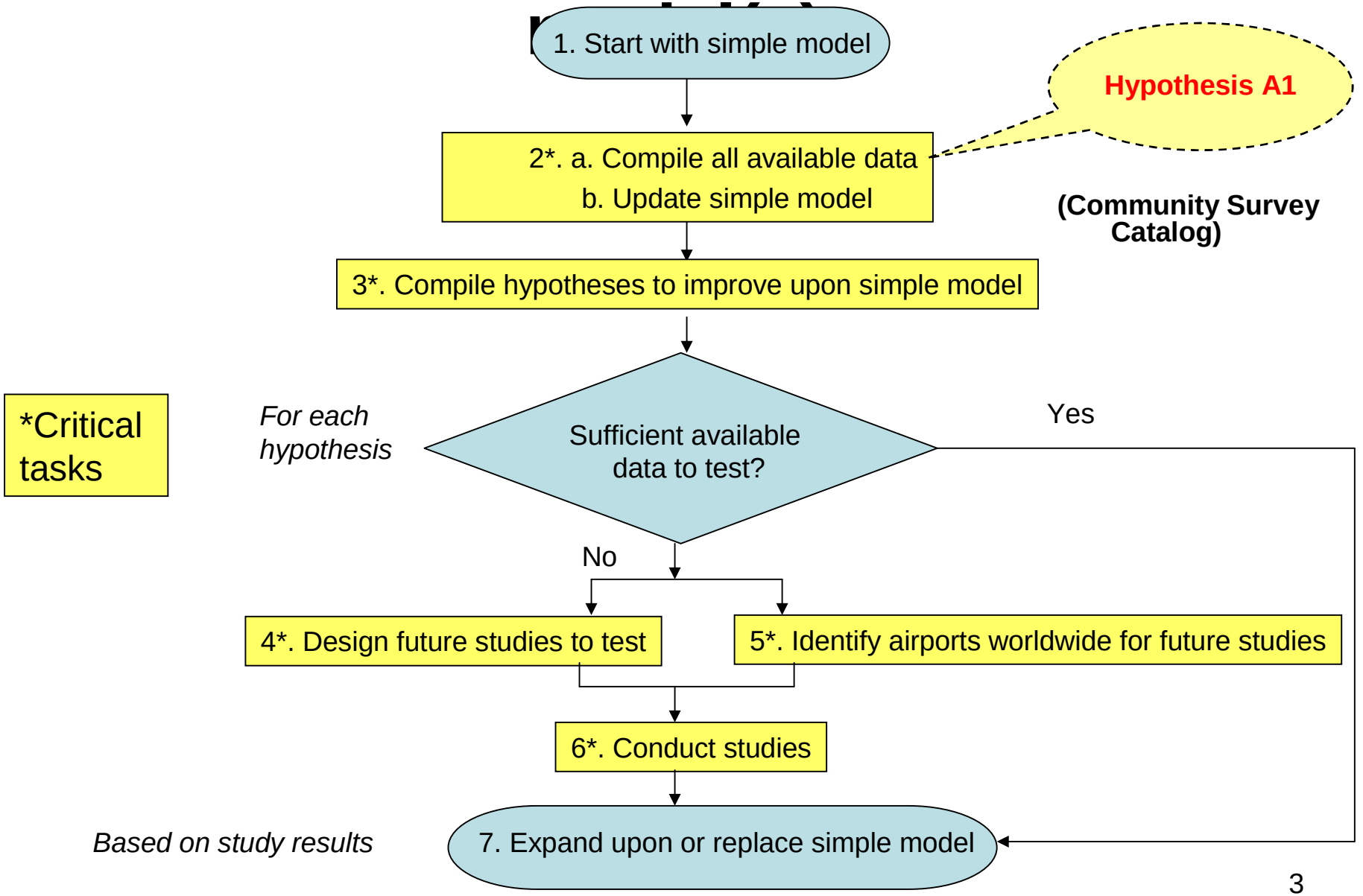
- Relationship bet. DNL & %HA works as a **first-order approximation** of annoyance from long-term aircraft noise exposure



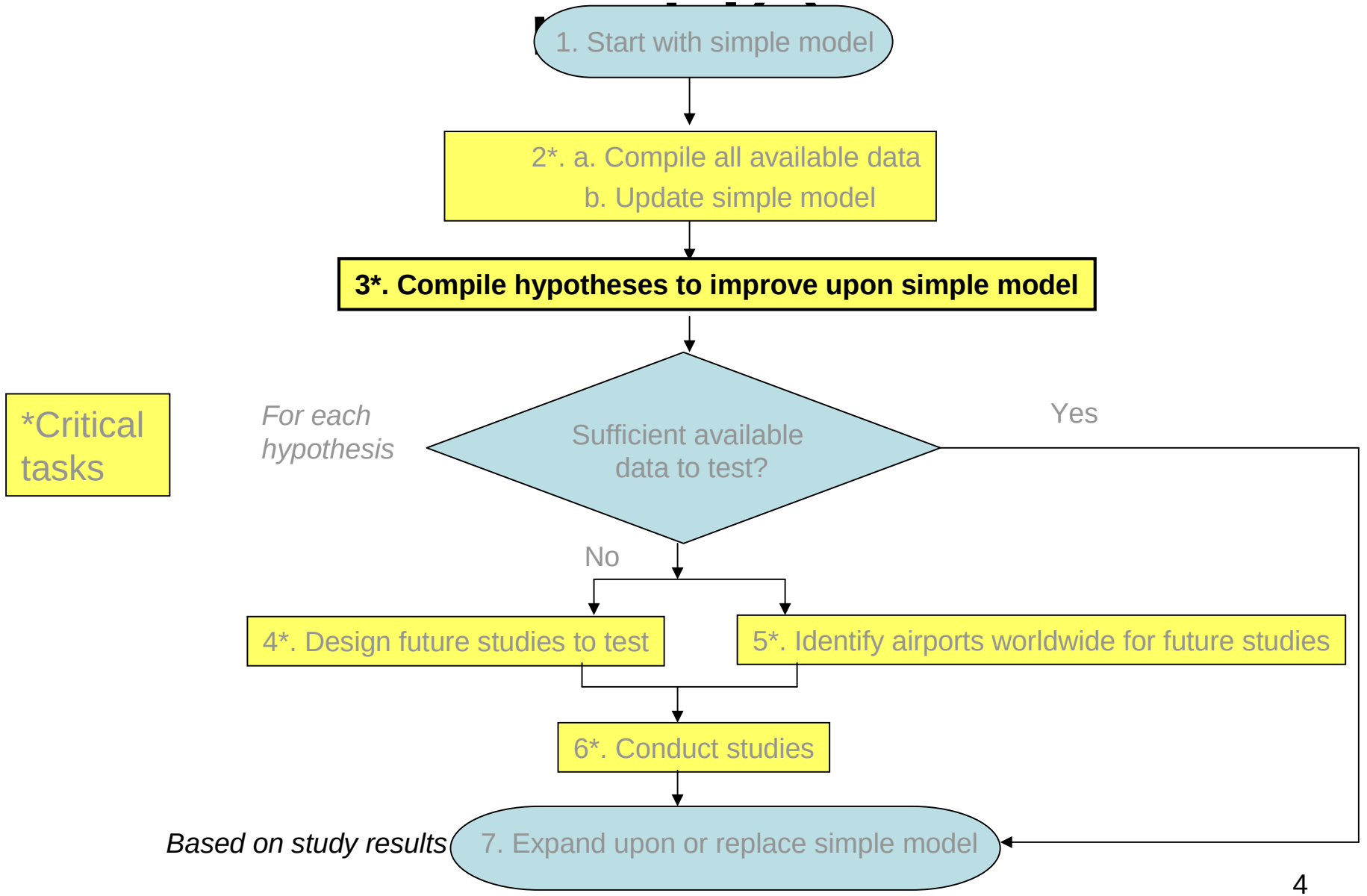
Day - Night Average Sound Level in dB		40	45	50	55	60	65	70	75	80	85	100
Calculated %HA Points	USAF	0.41	0.831	1.66	3.31	6.48	12.29	22.1	36.47	53.74	70.16	82.64
	SCHULTZ	0.576	1.11	2.12	4.03	7.52	13.59	23.32	37.05	53.25	68.78	81

[FICON 1992, Federal Agency Review of Selected Airport Noise Analysis Issues]

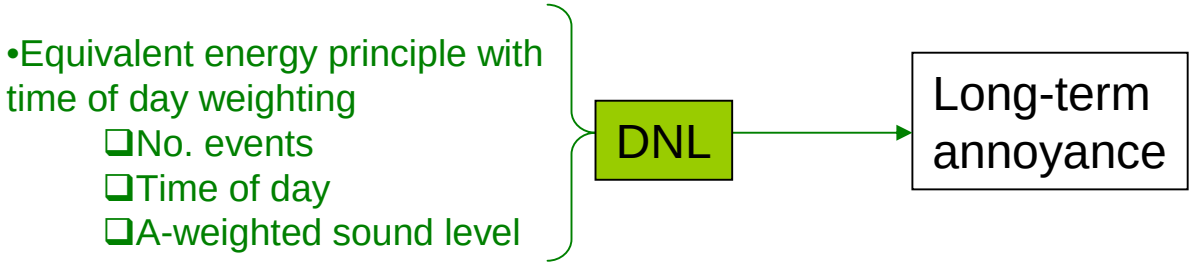
Roadmap to improved annoyance



Roadmap to improved annoyance



Simple model for annoyance

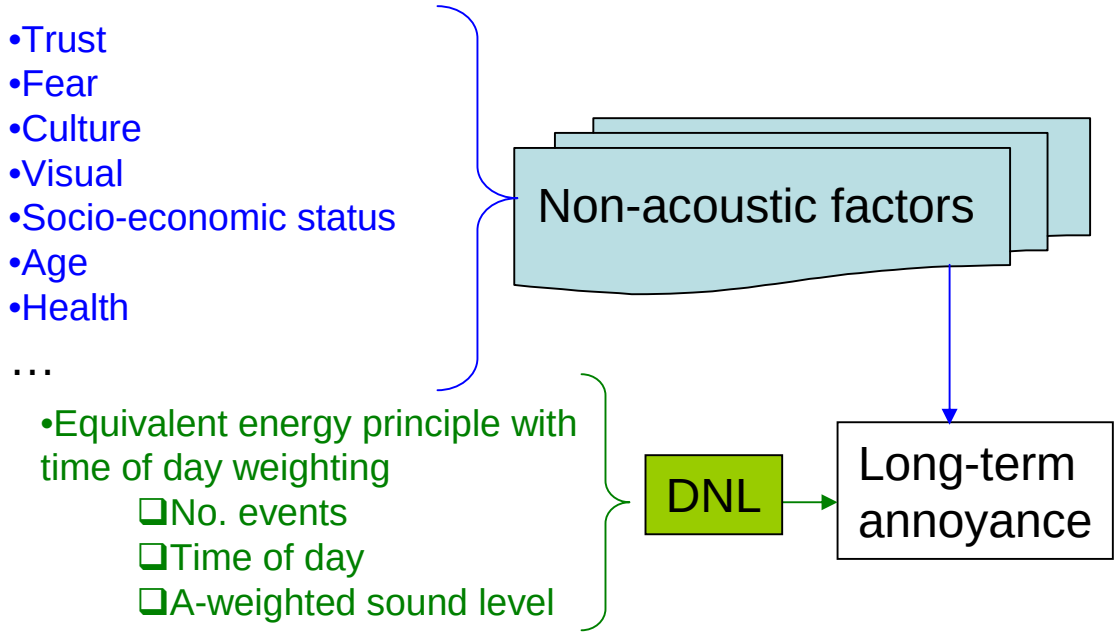


Discussion – Hypotheses A2:

All other things being equal, single %HA vs DNL curve may not be generalizable because of

- *Effect of time: Relationship between DNL & %HA has shifted upward over time*
- *Effect of step change: Relationship between DNL & %HA is shifted upward for communities that experience step change in noise exposure relative to those exposed to gradual change*
- *Effect of type/number of aircraft operations: Relationship between DNL & %HA is different for communities exposed to primarily commercial operations relative to communities exposed to primarily general aviation or military operations.*

Alternative models of increasing complexity (1)



Assumptions and/or have sufficient evidence

Hypothesis #A3

•Non-acoustic factors contribute to ***community annoyance*** and their contribution is quantifiable.

Discussion:

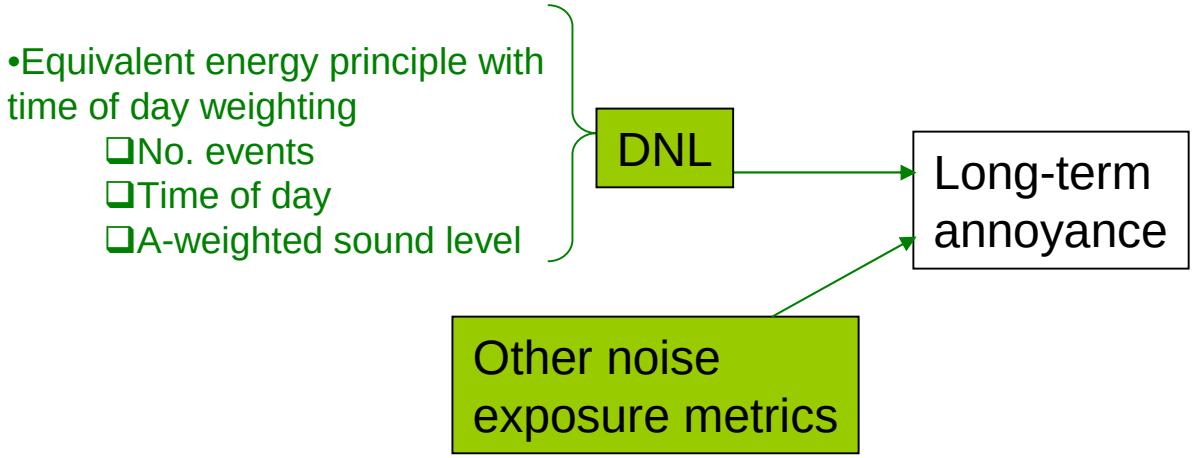
- **What are the most Important non-acoustic factors to study?**
- **Which non-acoustic factors can be dismissed?**

Alternative models of increasing complexity (2)

Assumptions and/or have sufficient evidence

Hypothesis # A4

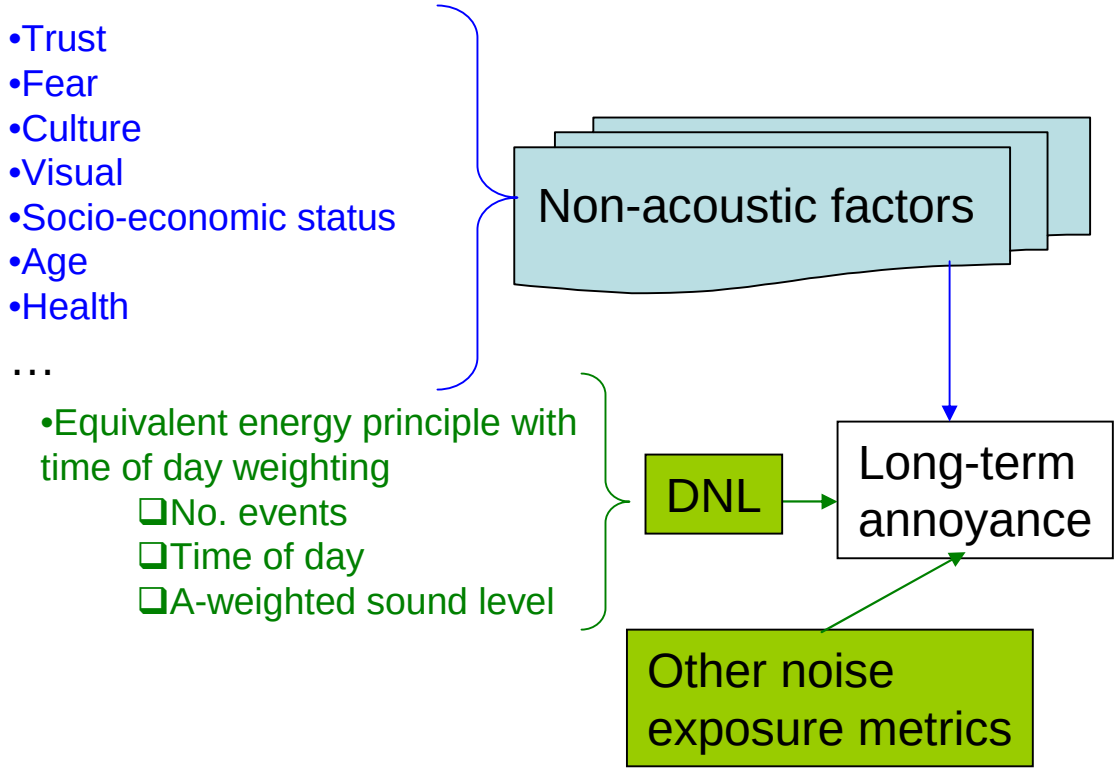
- DNL may not sufficiently capture elements of noise exposure that cause long-term annoyance.
- Self-reported annoyance may be complemented by other ways to measure annoyance



Discussion – corollary candidate hypotheses

- *Numbers of operations influence extent of annoyance, independent of exposure (DNL)*
- *Sound levels of loudest aircraft influence extent of annoyance, independent of numbers of quieter aircraft*
- *Aircraft noise levels as heard indoors correlate better with the extent of annoyance than do outdoor aircraft noise levels*
- *24-hour exposure metrics become less correlated with extent of annoyance if aircraft operations are concentrated either in the daytime or the nighttime*
- *Duration of "quiet periods" correlates with extent of annoyance*
- *Vibration and/or rattle from low frequencies influence extent of annoyance*
- *Acoustic metrics that correlate with other noise effects (such as speech interference, sleep disturbance) correlate better with extent of annoyance than does DNL*

Alternative models of increasing complexity (3): combining (1) and (2)



Alternative models of increasing complexity (4)

- Max sound level
- No. events
- Time of day
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- Roughness
- Duration of events
- Tonality
- Ambient sound levels
- Gradual vs. sudden change

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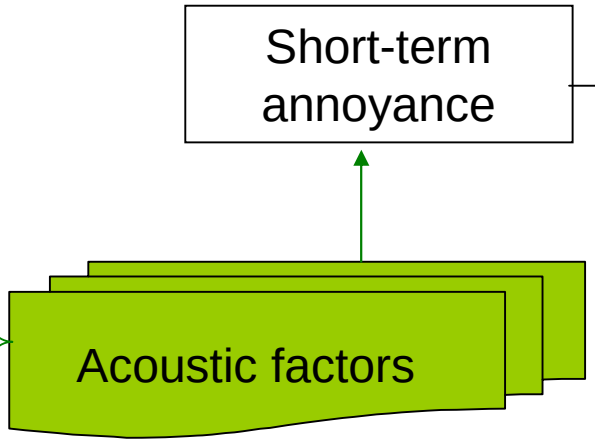


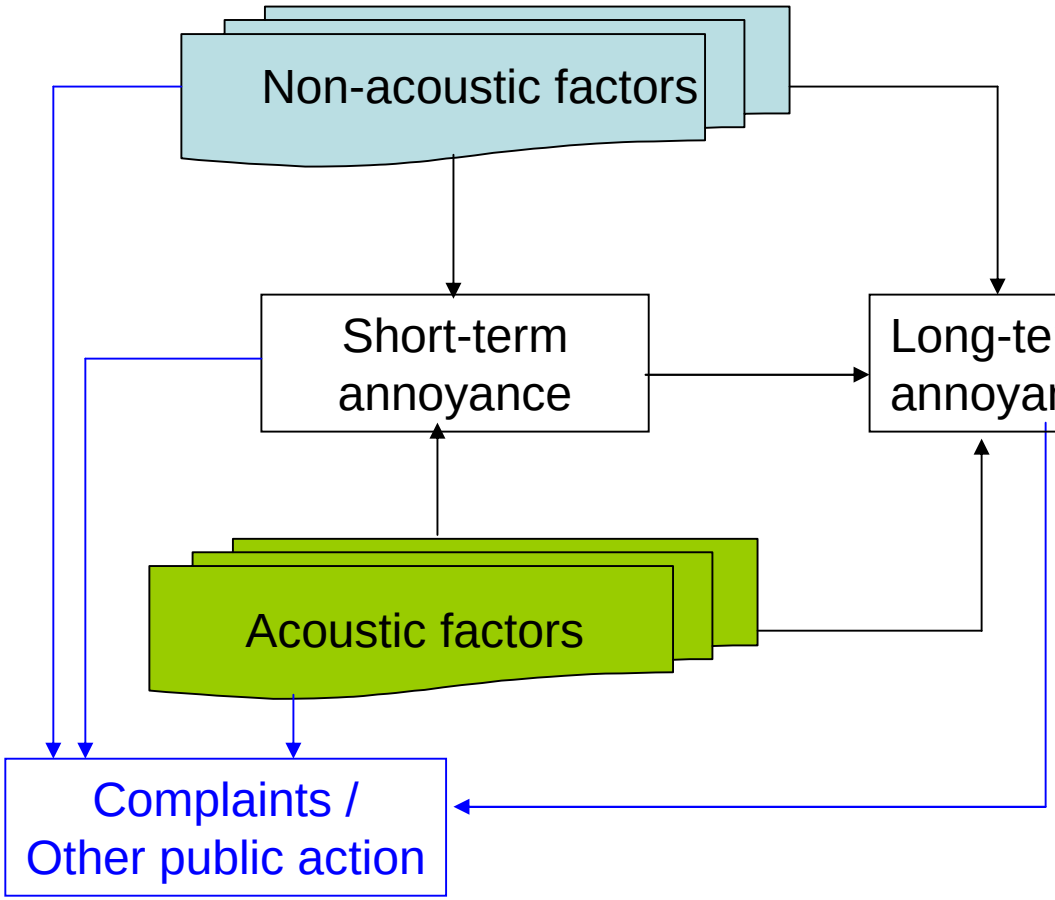
Assumptions and/or have sufficient evidence
Hypothesis #A5

- People respond to individual noise events.
- Long-term annoyance can be correlated with short-term annoyance from single events.
- Percent of population that is noise sensitive (self-reported or physiological) influences extent of annoyance

Discussion:

- **What are the most Important single-event acoustic factors to study?**
- **Can laboratory tests of single events be used to build a model of long-term annoyance?**
- **Which acoustic factors can be dismissed?**

Companion research to annoyance model(s)



- Model for public action
- Hypothesis A6
  - *An extensive database of complaints will be useful in understanding possible causes of complaints*
  - *Analysis of more than a decade of experiences around the world with new or extended runways or altered airspace use will provide greatly improved understanding of public action*
- Communicating noise exposure
- Hypothesis A7
  - *There are effective methods for communicating with the public about aircraft noise, its effects and what changes in noise will mean to the individual.*

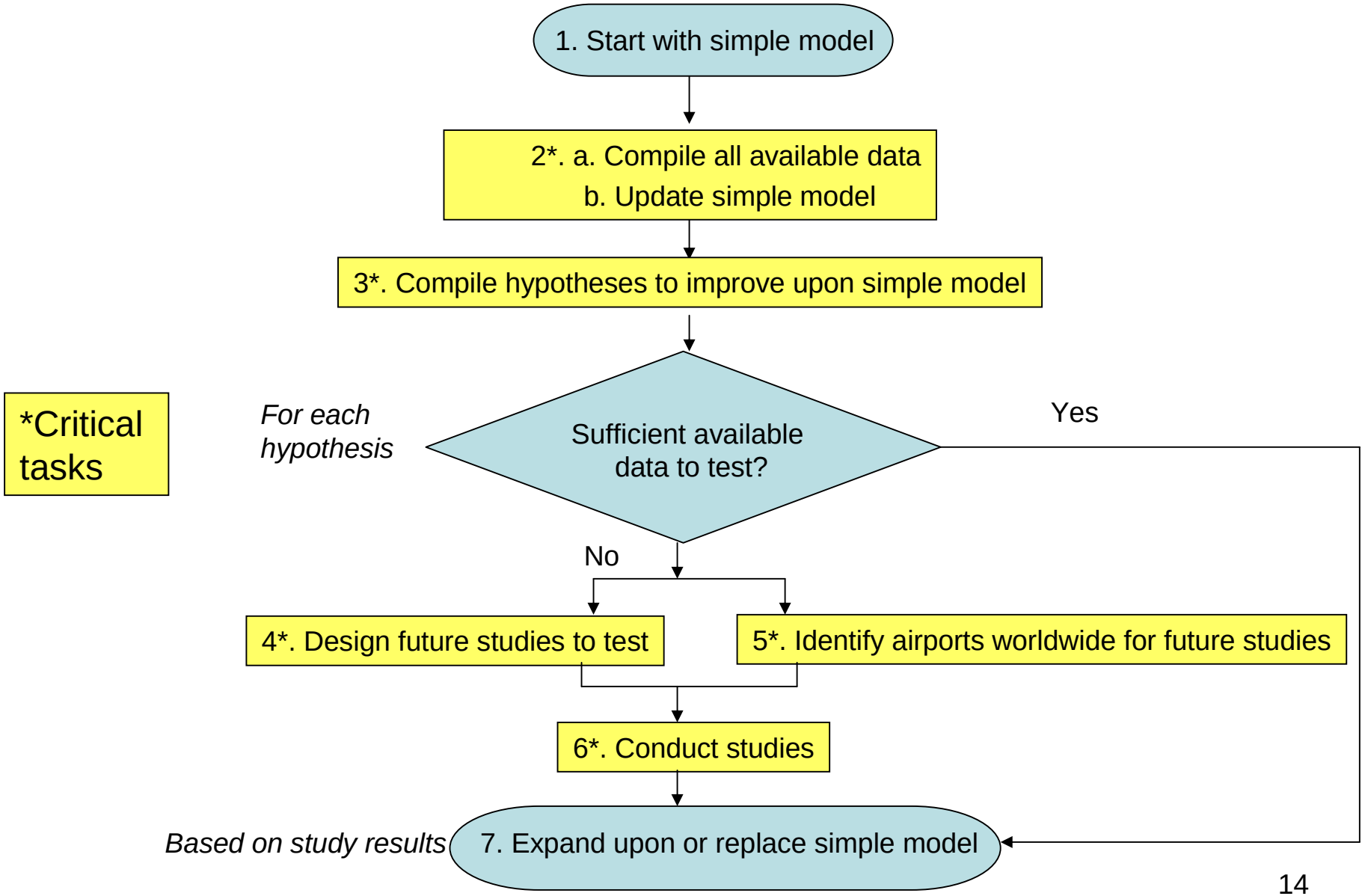
Additional task

- *Investigate applicability of EPA risk assessment methodology*
  - *FAA may need to establish new land use compatibility guidelines based on the above proposed research*
  - *EPA has long-term experience in judging risk and costs for setting thresholds of exposure*
  - *FAA may be able to benefit from the EPA experience*

Summary of Main Research Areas

- 1 - Assemble Available Data
  - Improve simple model
- 2 - Examine DNL Details
  - Shifting sensitivity
  - Step changes
  - Type / number of aircraft
- 3- Effects of Non-acoustic Factors
- 4 - Acoustic Metrics Other than DNL
- 5 - Short- and Long-Term Annoyance Relation
- 6 - Public Reaction – (e.g. Complaints)
- 7 - Methods of Communication
- EPA Risk Assessment Experience

Recap of Roadmap Approach



Considerations for future studies

- Collaborative approach
  - Build on state-of-art research to devel`op survey questionnaire
  - Identify state-of-art technologies to acquire noise data and conduct surveys
  - Plan similar studies for airports worldwide