



NSF
Center for
Nanotechnology
in Society
at **UCSB**

The Nano Enterprise at the Intersection of
Society, Environment and Sustainability

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CNS-UCSB
Center for Nanotechnology in Society

Responsible Development & Environment

ELSI (ethical, legal, and societal implications) considerations “are deeply embedded in the NNI’s commitment to **responsible development** of nanotechnology.” (US NNI, 2011) Attention to the environmental implications is a key aspect of this effort ...

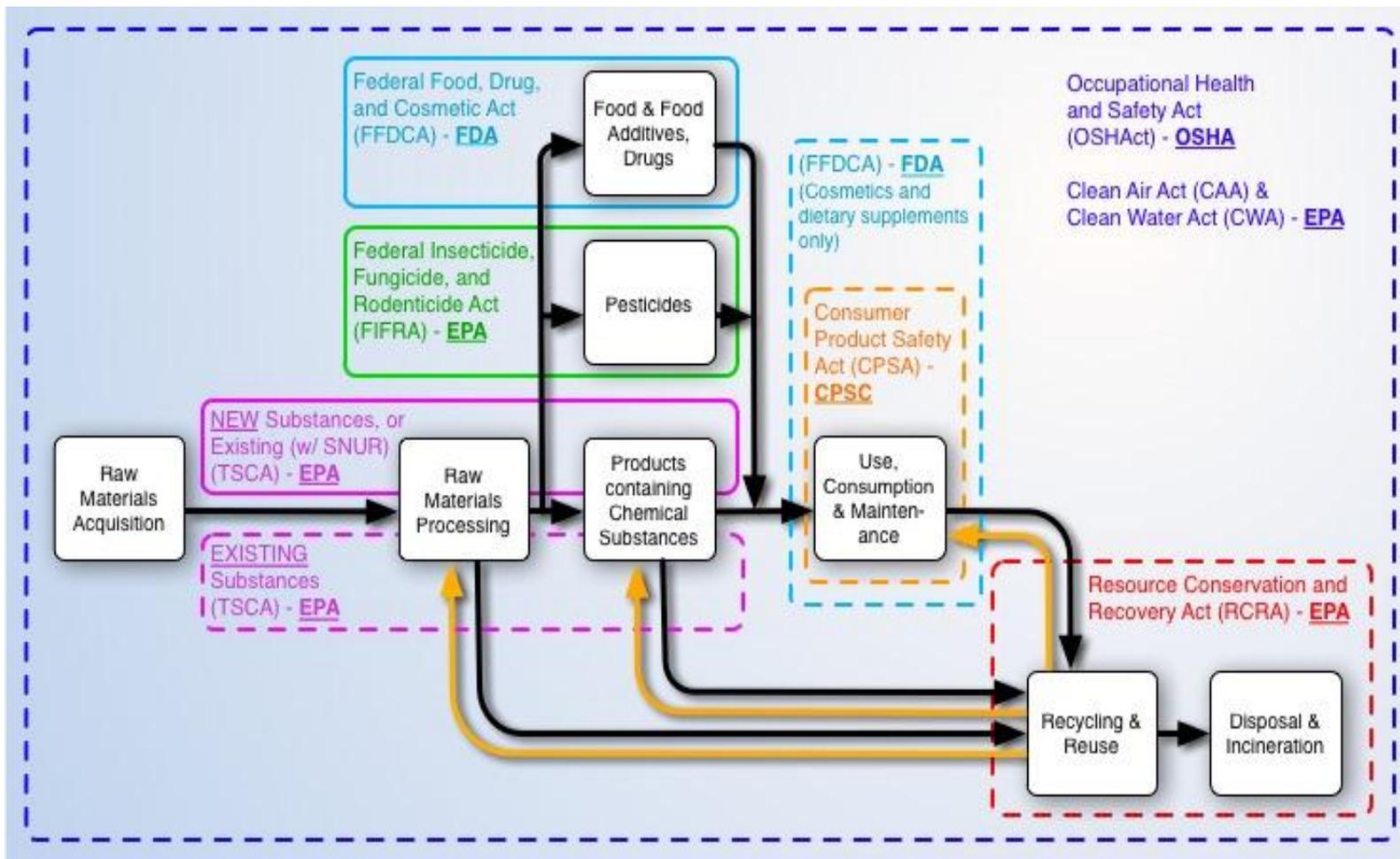
(1) Policy implications and regulatory challenges

(2) Comparing Expert Positions on ENM risks and regulation

(2) Industry Environmental Safety Practices

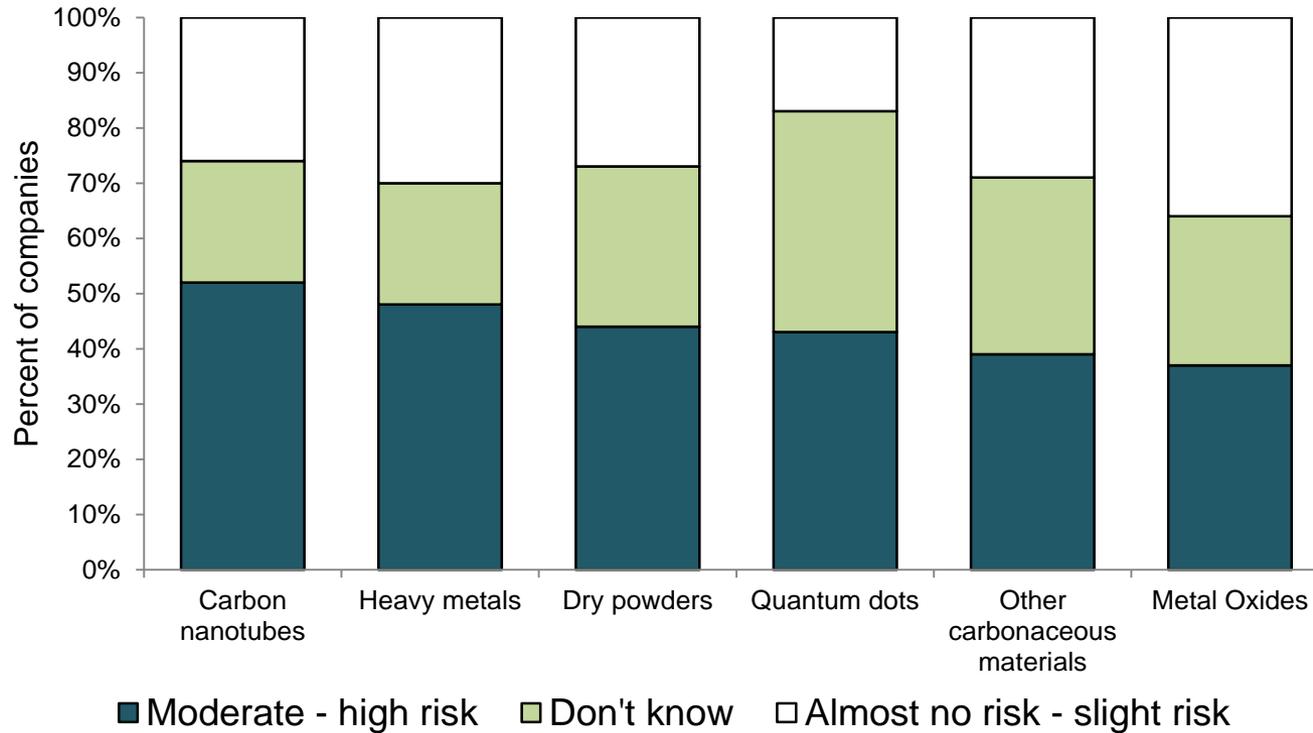
(3) Public perceptions and consumer implications of the environmental impacts of ENM

US REGULATORY CAPACITIES ACROSS THE NANO-LIFECYCLE



Beaudrie, Kandlikar, Satterfield (2012) under review

Industry Risk Perception—International Survey of ENM Company Workplace Environment



Phone & web survey of 78 companies in 14 countries

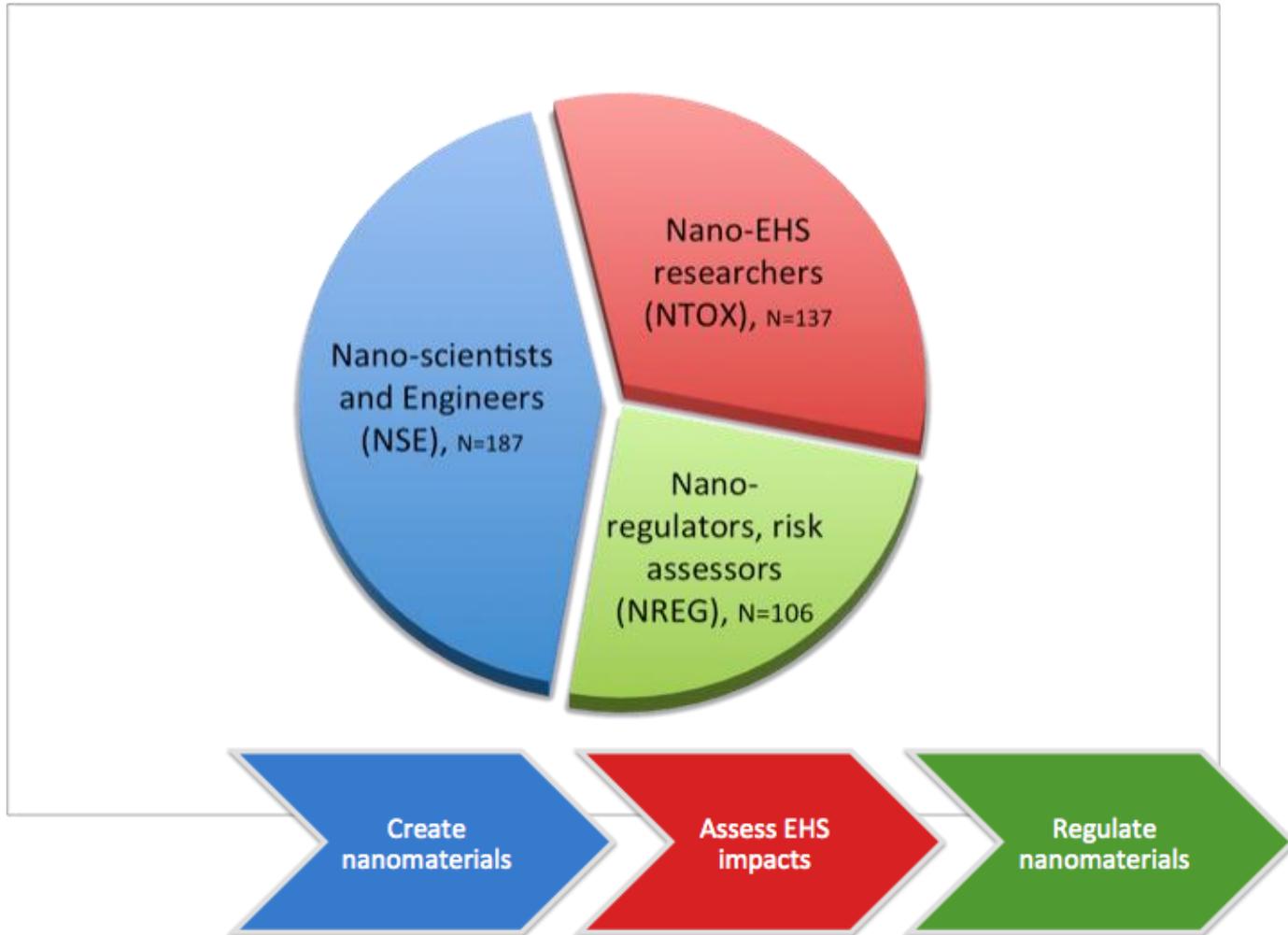
Large majority of industry leaders are uncertain or show moderate/high perceived risk re: ENMs, combined 'don't know' plus moderate/high risk = 64%(metal oxides) - 83% (quantum dots)
 → yet *not* self protective and prefer autonomy from regulation



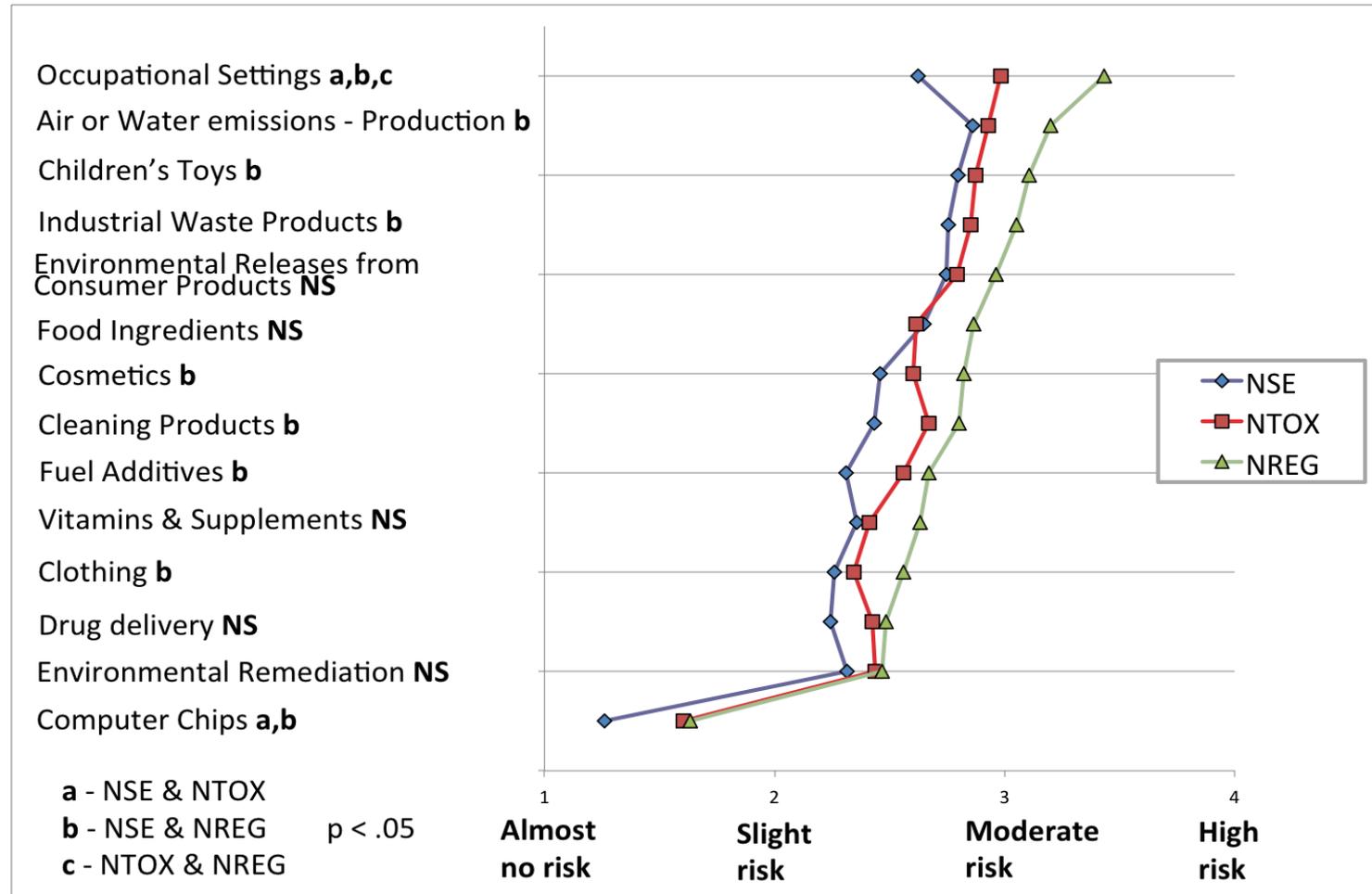
Engeman, et al, 2012 Journal of Nanoparticle Research 14(3):749-760

Nanotechnology Expert Survey

Beaudrie, Satterfield, Kandlikar, Harthorn. In preparation

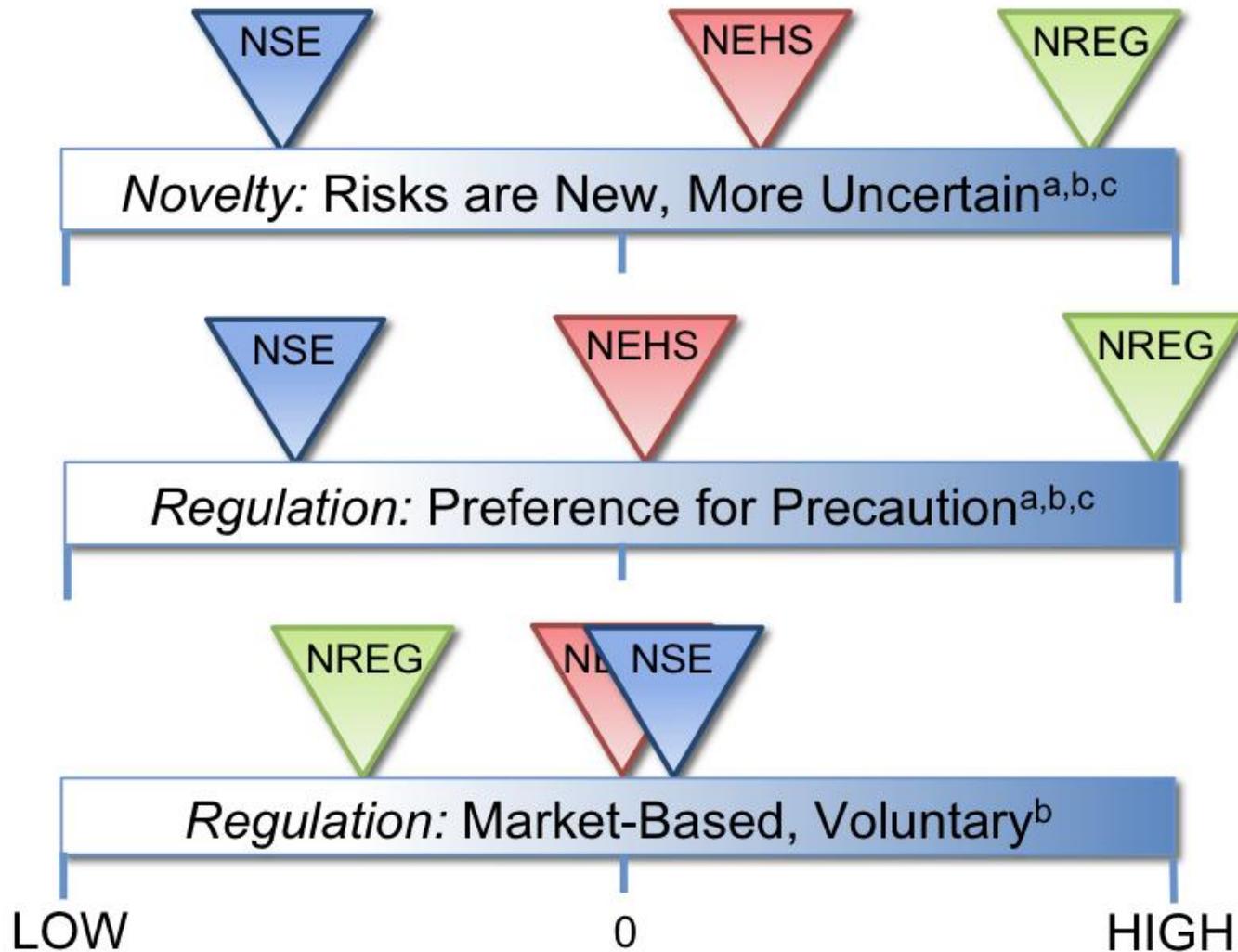


Expert Studies--Small but Consistent Differences across Scientists' and Regulators' ENM Risk and Benefit Perceptions

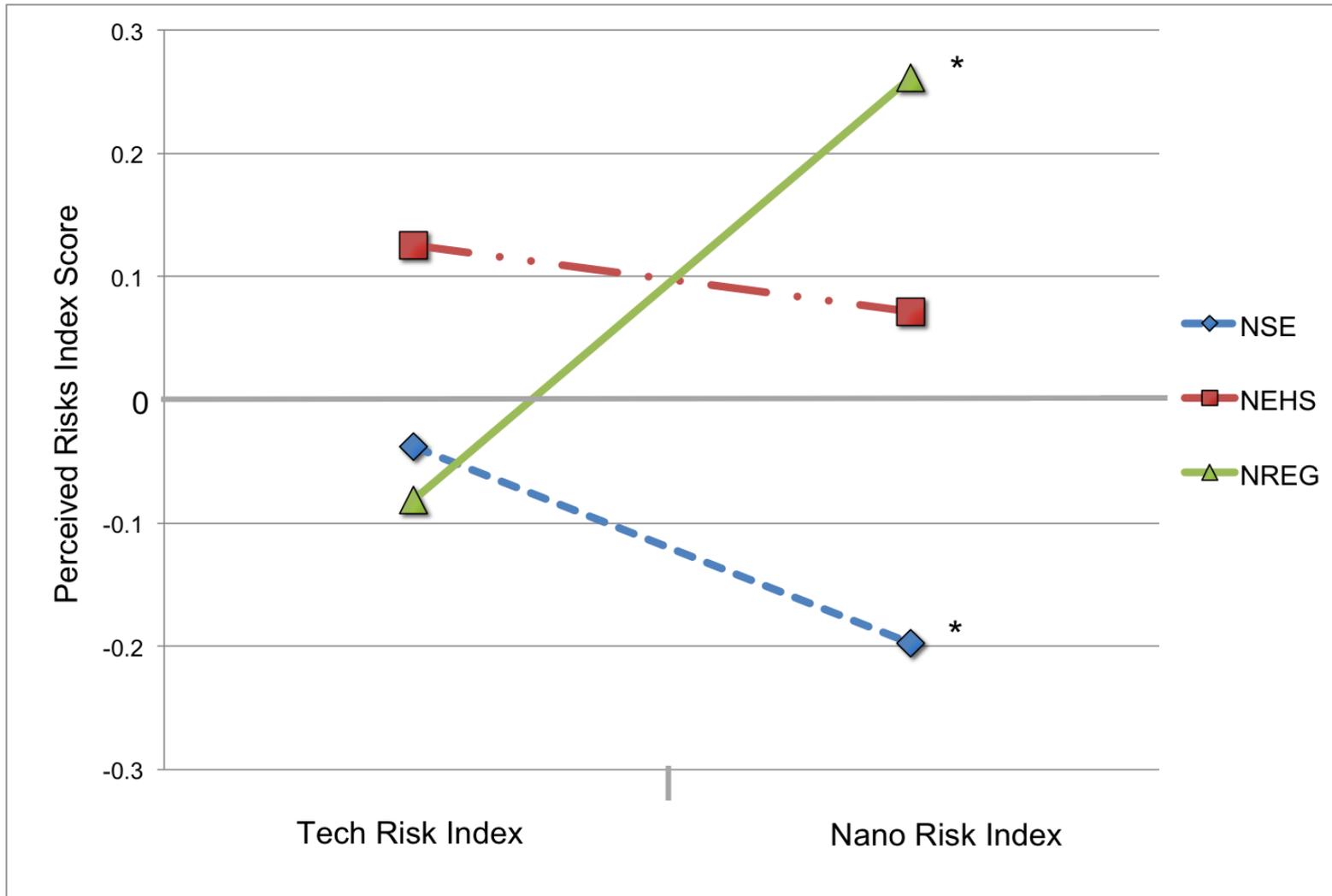


- Small but significant differences in risk views by expert affiliation/discipline, with **regulators judging risks to be higher**
- Greatest disagreement in views about **workplace risk**
- Most agreement about **nano-remediation**

Mean scores for the 'Novelty' and 'Attitudes toward Regulation' indices for NSE, NEHS, and NREG



Tech Risk Index and Nano Risk Index scores by expert group



Structured Decision Making Workshop ...Process

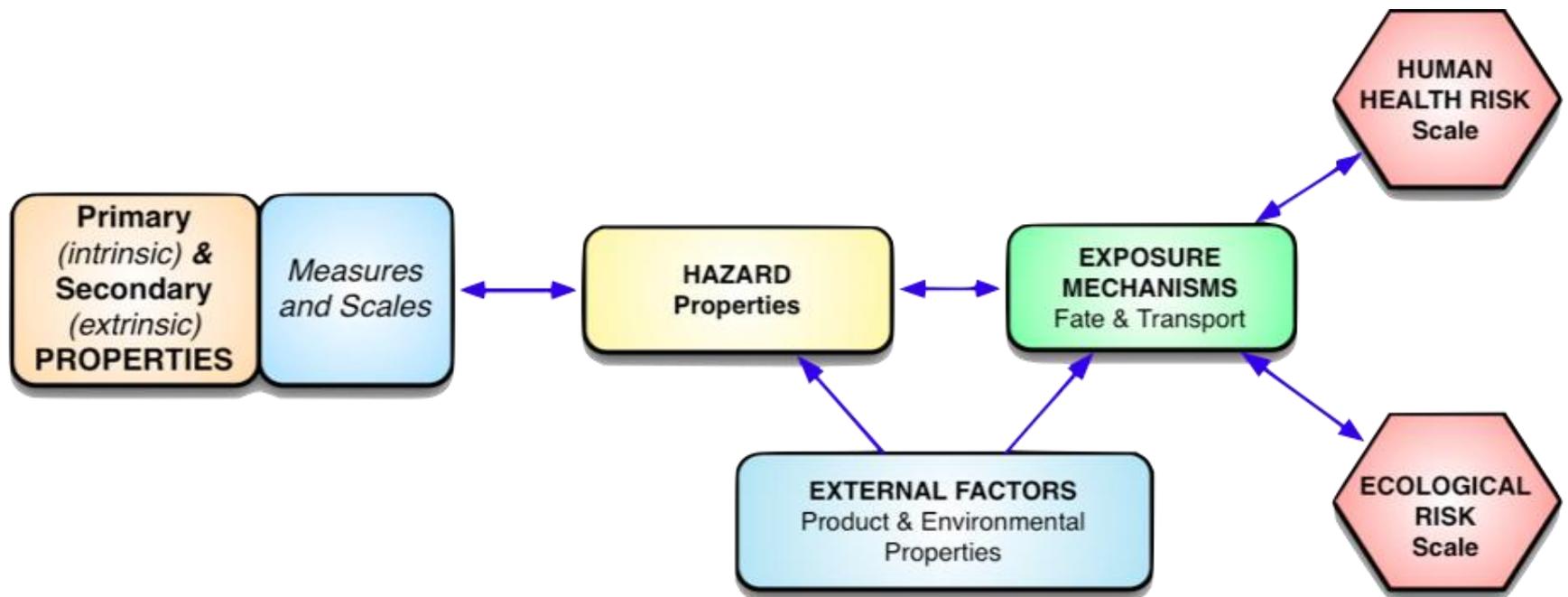
(Gregory, Long, Kandlikar, Satterfield et al)

- * NanoRiskScreeningTool
- * Preliminary framework & discussion
- * Case studies & discussion
- * Collaborative model building via SDM

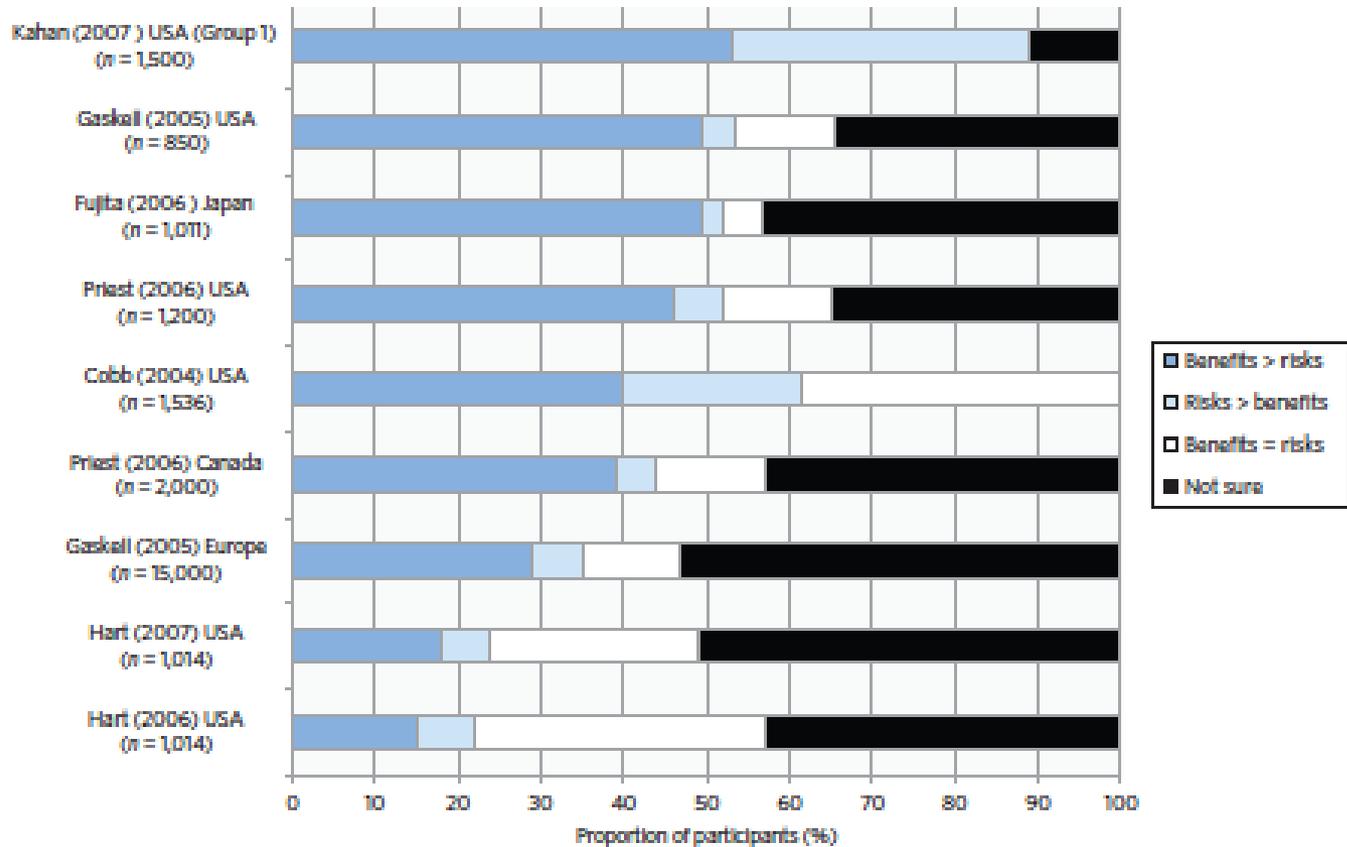


- * Breakouts:
 - * *Exposure & Toxicity components*
 - * *Properties & Measures*
 - * *Product Characteristics*
- * Mock-up of a final model & discussion
- * Value of the NRST, Future work, Next Steps

Initial Screening Framework



Public Views of Nanotechnology Risks & Benefits





“Intuitive cognition and environmental health”

- Most work about health risks to individual or family?
- Very little about environmental risks?
- Thinking fast or rapid assessment logics for evaluating risks (Fishhoff, Slovic, Lichtenstein; Kahneman and others)
- ***Do people rely on their senses of sight, taste & smell, or on other cues, to detect harmful or unsafe environmental media, namely air, water & soil, forest, desert, mountain, ocean AWS?***

Methods: Environmental Risk Perception Surveys

- Two survey waves completed (2010 and 2012)
- Web administration – US Population Generalizability
- Both approximately 22 minutes in length
- Both ask for:
 - ratings about air/water/soil (AWS), nanotech knowledge and awareness, environmental values, and intuitive toxicology metrics.

2010 Specifics

- Experimental nature
- N=745 (F=381; M=367; White=537; nonwhite=157)
- Unique Questions: trust in sci & reg (incl. consumer safety), first study to use AWS distinctions.

2012 Specifics

- N=2500 (F=1281; M=1219; White=1735; nonwhite=765)
- Unique questions: AWS w/specific envir context; comparative risk object battery, ENM vignette statements, demo oversample.

B) How do people judge environmental media? Scales

Mostly pure	<input type="checkbox"/>	Mostly contaminated					
Full of micro life forms	<input type="checkbox"/>	Empty of micro life forms					
Recovers easily from human impacts	<input type="checkbox"/>	Recovers poorly from human impacts					
Self-cleaning with time	<input type="checkbox"/>	Needs human intervention to become clean					
Visible	<input type="checkbox"/>	Invisible					
Easy to control	<input type="checkbox"/>	Difficult to control					
Easy to sample and test	<input type="checkbox"/>	Difficult to sample and test					
Easy to measure	<input type="checkbox"/>	Difficult to measure					
Can be touched or felt	<input type="checkbox"/>	Cannot be touched or felt					
Easy to describe	<input type="checkbox"/>	Difficult to describe					
Healthy	<input type="checkbox"/>	Unhealthy					

What's behind how we perceive air, water & soil?

Tangibility

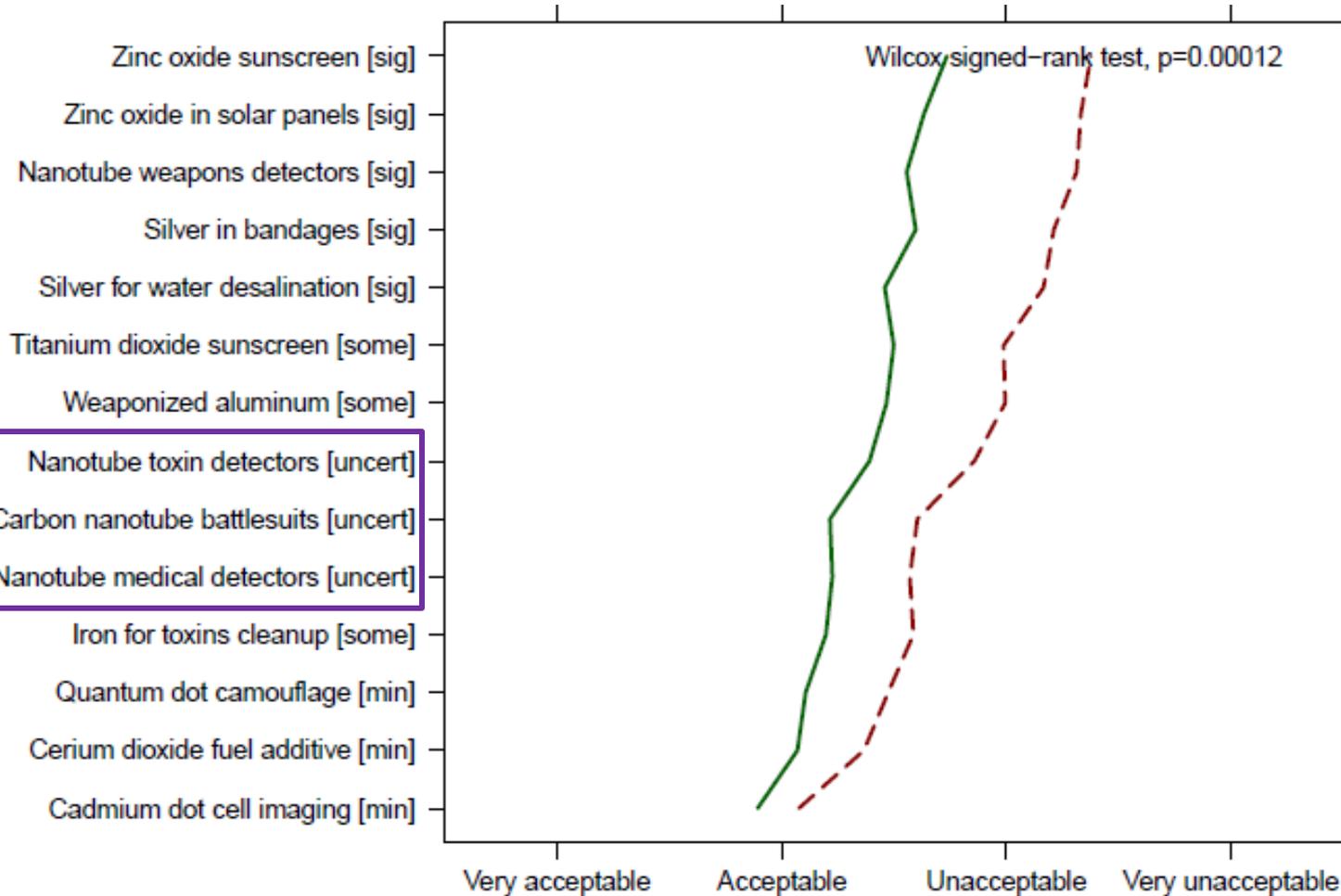
- Can/cannot be *touched* or *felt*
- *Visible/invisible*
- Easy/difficult to *describe*
- Easy/difficult to *measure*
- Easy/difficult to *sample & test*

Resilience

- *Recovers* easily/poorly from human impacts
- Self *cleaning*/needs human intervention to become clean
- Mostly *pure/contaminated*
- Easy/difficult to *control*



UC CEIN/CNS-UCSB: Public Perception of ENM Environmental Risk: Shaped by Risk Messages & Perceptions of Environmental Media



Green line: Air, water and soil recover easily, are self-cleaning, mostly pure, and easy to control.

Red line: Air, water and soil recover poorly, need human intervention to become clean, are mostly contaminated and difficult to control.

- Stated risk level affects acceptability
- Perceived environmental ‘resilience’ affects acceptability
- Risk uncertainty → reluctant to judge

Traditionally, affect predicts risk and stigmatization, but what about affective indifference? as a predictor of stigmatization

Aims:

- Understanding possibilities for stigmatization of nanotechnologies in the face of a major risk event, given high 'don't know' and high 'affect ambivalence'.
- Stigma = degree of avoidance given a 'positive' versus 'negative' news message about risk and safety management for ENMs

Methods:

- U.S. National survey (N=1,100)

River cleanup leads to healthier fish stocks

DoE announces new, cheaper fuel

Company accepts all responsibility

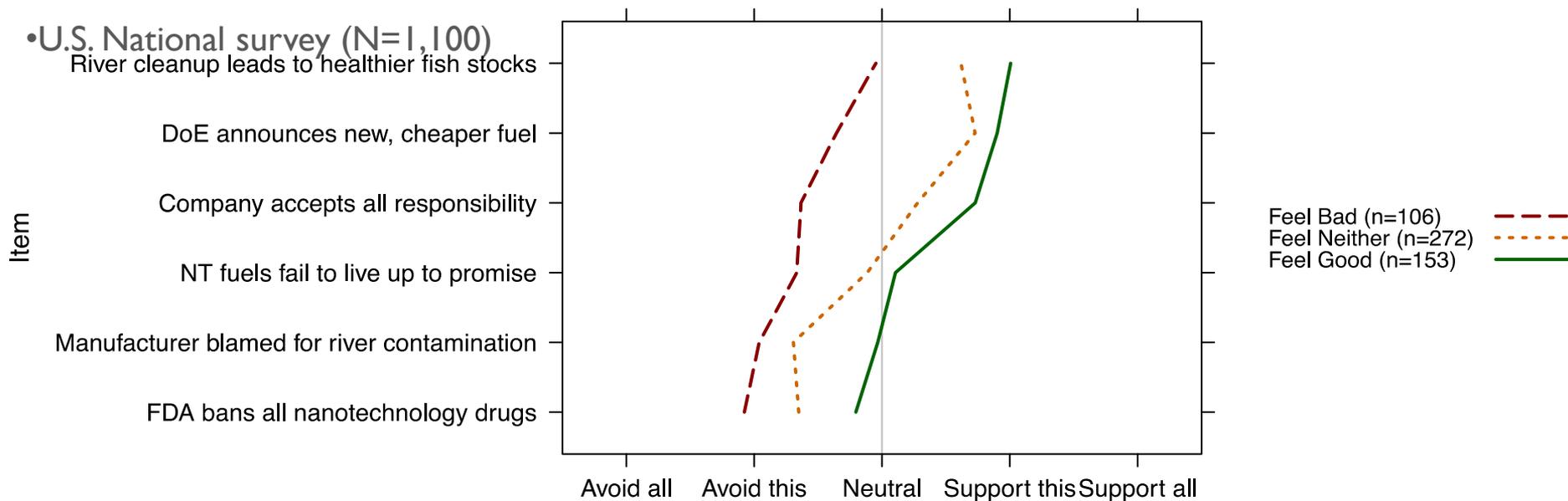
NT fuels fail to live up to promise

Manufacturer blamed for river contamination

FDA bans all nanotechnology drugs

Main Findings:

- High levels (51%) of affective indifference about NTs
- Negative affect → would stigmatize NTs even in positive scenarios
- Positive affect → would only stigmatize NTs in most negative scenarios

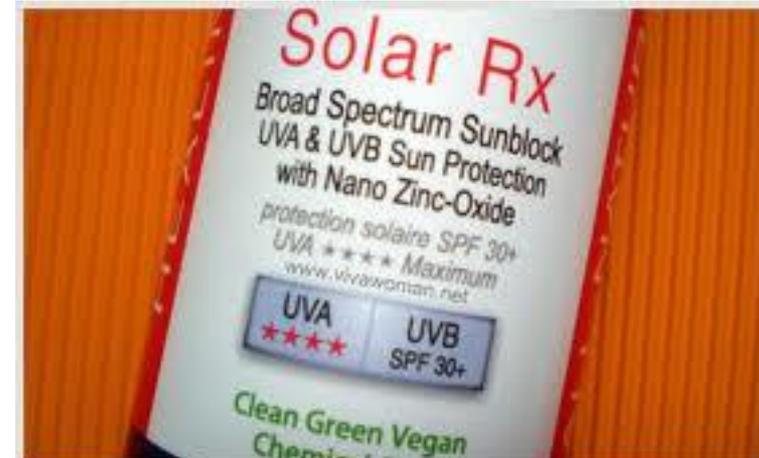


Mean ratings of the six stigma items

Satterfield, Corner, Pidgeon, Pitts, & Harthorn, in prep

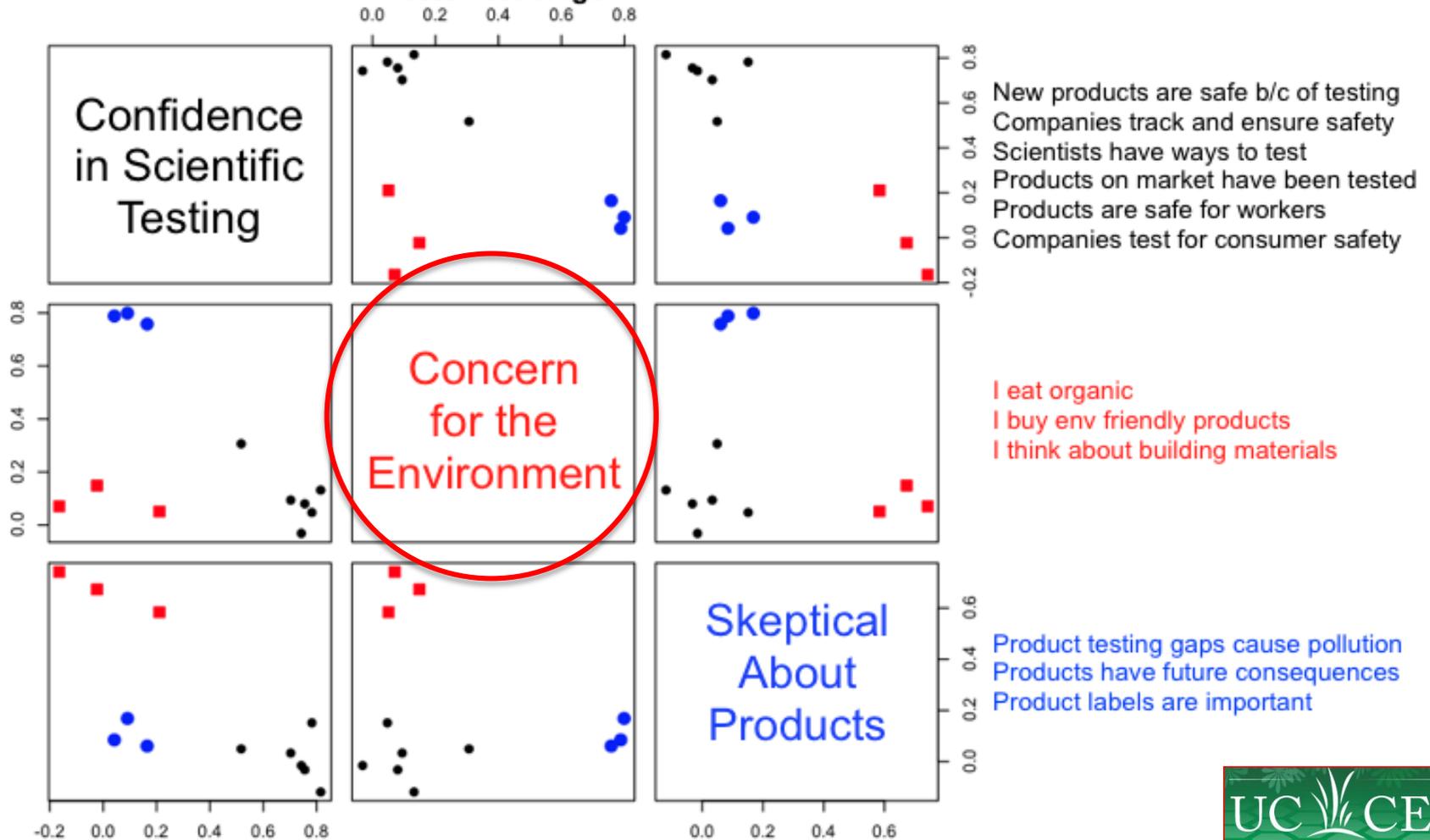
Nanotechnology, Consumer Products and Publics

- Awareness of nanotechnology among the public(s) is low
- The public(s) are likely to come in contact with nanotechnology via consumer products
- Can we consumer product opinions to predict overall nano-acceptability?



Public Views of Consumer Safety

Principal Component Analysis
Factor Loadings



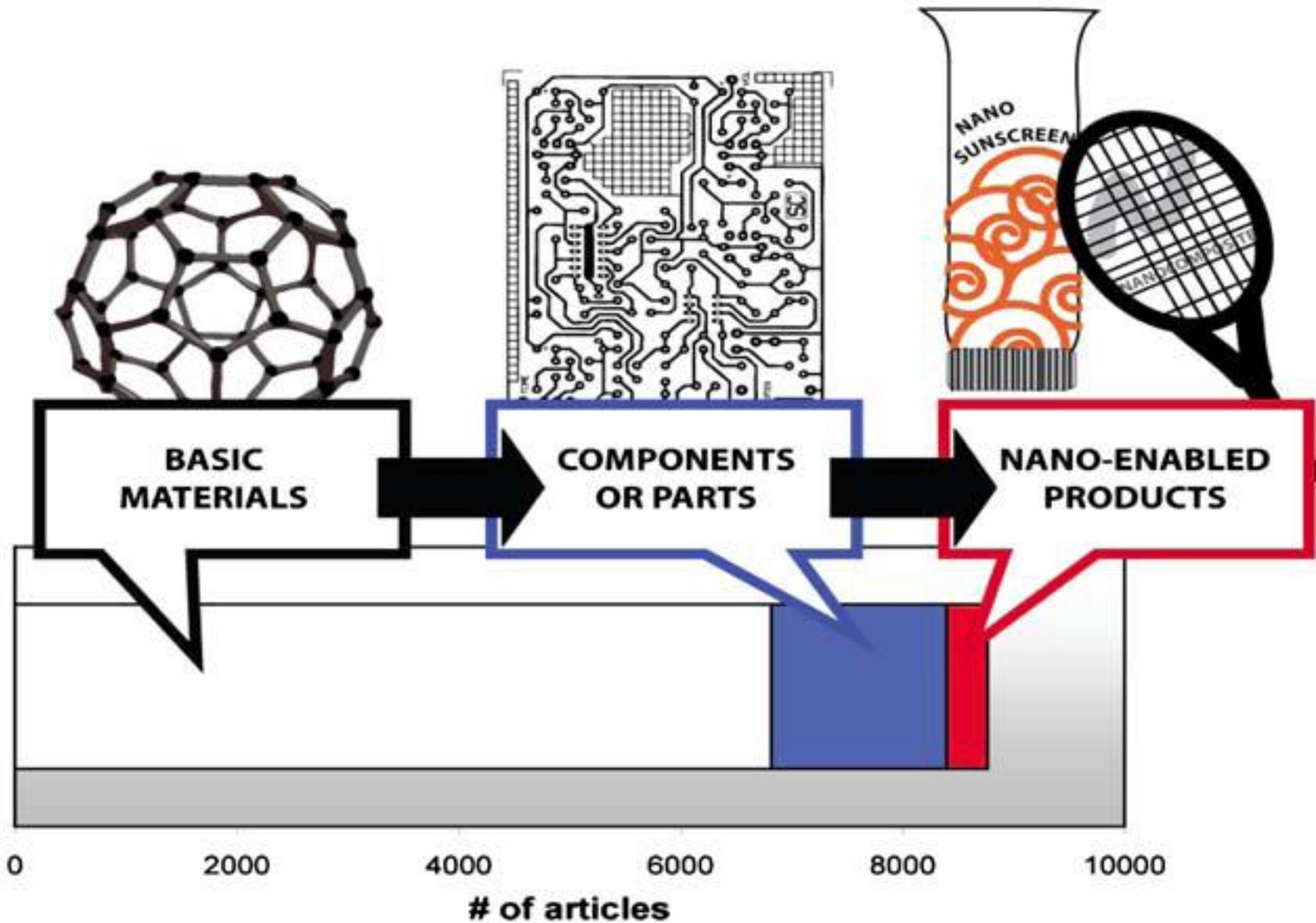
CONCLUSIONS IN BRIEF ...

- ✓ Views of nano risks to environment vary enormously between and within expert, industry and public groups
- ✓ Regulation remains vital to responsible development, yet gaps across the life cycle and across experts own need be addressed and indicate considerable variation
- ✓ Public views on environmental media, risks and benefits are affected by a range of factors, all of which need become central to risk communication and public engagement activities ◀
- ✓ THANK YOU ...

Thank you.

- ▶ Many people to acknowledge: Faculty researchers: Nick Pidgeon, Joseph Conti, Patricia Holden, Milind Kandlikar, Robin Gregory, Graham Long, Paul Slovic; postdocs: Gwen D’Arcangelis, Mary Collins, Adam Corner, Anton Pitts; grads: Cassandra Engeman, Christian Beaudrie, Shannon Hanna, Laura DeVries.
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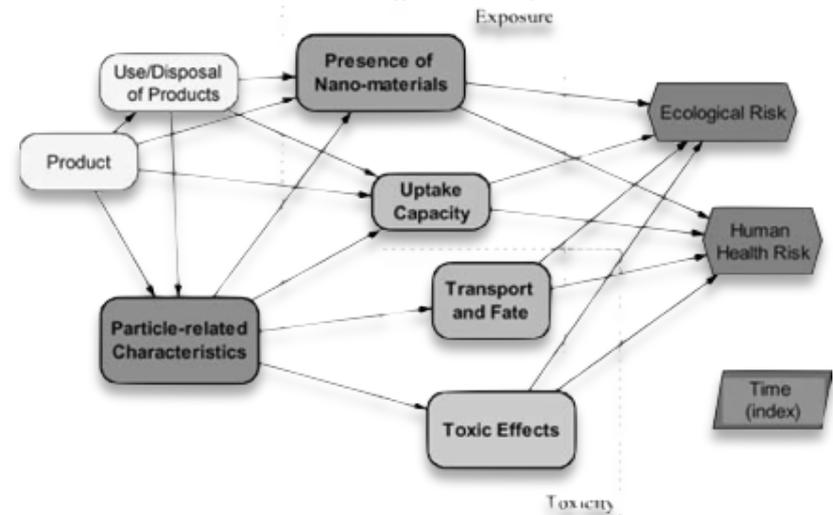


* Basic material research is assigned to categories like "inorganic materials" and "particle phenomena". Components are articles that are categorized as substances in a specific environment or processes. Products are those categories such as "food" and "materials and products". Some articles are placed in multiple categories.

Risk Screening & Expert Judgment

- * Expert Judgment under high uncertainty
 - * Synthesize rapidly expanding knowledge-base into useable tools
 - * Classify ENMs as high / medium / low risk
 - * Identify 'hot spots' along the ENM life cycle
- * Several approaches:

		Probability Score			
		Extremely Unlikely (0 - 25)	Less Likely (26 - 50)	Likely (51 - 75)	Probable (76 - 100)
Severity Score	Very High (76 - 100)	RL 3	RL 3	RL 4	RL 4
	High (51 - 75)	RL 2	RL 2	RL 3	RL 4
	Medium (26 - 50)	RL 1	RL 1	RL 2	RL 3
	Low (0 - 25)	RL 1	RL 1	RL 1	RL 2



Paik, S. et al. Annals of Occupational Hygiene 2008, 52, 419.

Morgan, K. Risk Analysis 2005, 25, 1621–1635.

- * There is a need for:
 - * Causal connection between physical/chemical characteristics and toxicity / exposure
 - * Consistent language and metrics

Experts Workshop

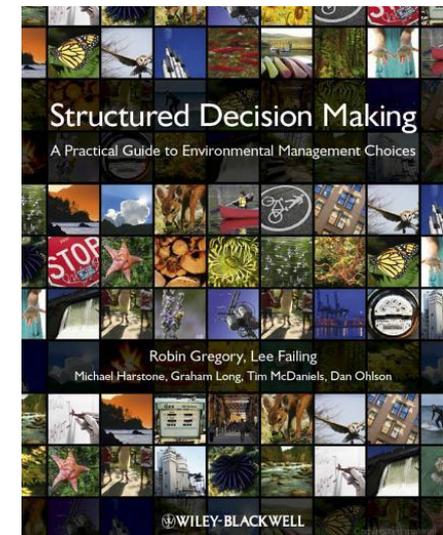
May 24-25 at UBC, Vancouver, Canada

- * **Nanotoxicology**
 - * *Human Toxicology*
 - *Eco-Toxicology*
- **Human Exposure**
- **Environmental Fate and Transport**

- * NIOSH
- * Lawrence Livermore National Lab
- * UCLA
- * Washington University
- * University of Alberta
- * University of Rochester
- * University of South Carolina
- * University of Minnesota

Structured Decision Making (SDM) approach

- * Appropriate when decisions are characterized by:
 - * *Complexity and uncertainty*
 - * *Difficult judgments – weighing the science, consequences of alternatives, priorities, risk tolerances*
 - * *High stakes, limited resources*
- * Engages experts and decision makers in productive decision-oriented analysis and dialogue



ENM risk vignettes

<ul style="list-style-type: none">✓ Medical application✓ Cadmium-selenide 'dots'✓ Minimal risk	<p>Coated cadmium selenide 'dots' are being developed to create highly sensitive images of cells and tumors, which can improve our ability to diagnose disease. Once excreted from the human body these 'dots' may break down and be released into the environment. Scientists have to date found, however, the risk they pose to be minimal.</p>
<ul style="list-style-type: none">✓ Environmental application✓ Iron nanoparticle✓ Moderate risk	<p>Iron is being developed in its nanoparticle form for use in cleaning up environmental pollution such as arsenic and other toxins in soil and water. Scientists find that nano-sized iron may pose some risk to the environment.</p>
<ul style="list-style-type: none">✓ Medical application✓ Zinc Oxide nanoparticle✓ Significant risk	<p>Zinc oxide is also being developed in its nanoparticle form for use in sunscreens. This makes lotions highly effective in absorbing UV rays. However, after use the zinc oxide nanoparticles washed down the drain will get into oceans, rivers, or wastewater, where scientists find they may pose significant risks to the environment.</p>

Acceptability of specific nanotechnologies

