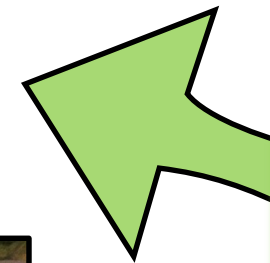


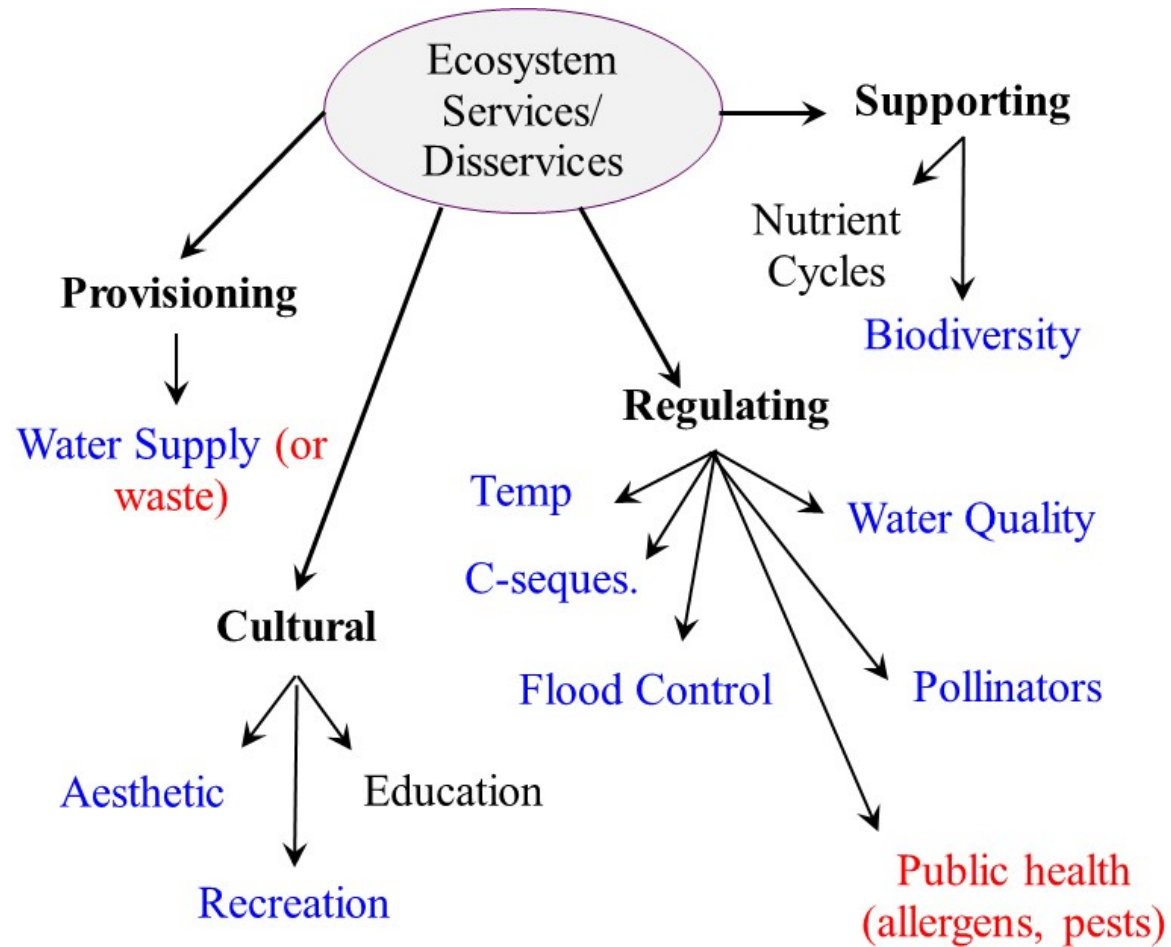
Perceived Ecosystem Services and Disservices of Natural Treatment Systems (NTS) for Urban Stormwater

Megan Rippy
Virginia Polytechnic Institute
and State University



NTS: Engineered ecosystems intended to manage stormwater using primarily natural processes

Why Perceived Services/Disservices?



The services and disservices people perceive NTS provide may influence public acceptance of (or advocacy for) NTS in urban landscape



Who's opinions matter?

If NTS designers don't feel they provide services, then who will?

Outline

- **Study Design**
 - study population: *next generation of NTS designers*
 - stated preference surveys
- **Perceived services and disservices of NTS for urban stormwater**
 - benchmark relative to other urban landscapes (*lawns, gardens, remnant native landscapes*)
 - multifunctional services/disservices bundles (co-associated services/disservices)
- **Drivers of landscape perceptions** (knowledge, attitudes about services/disservices, environmental worldviews, demographics)

How are NTS perceived and what drives those perceptions?

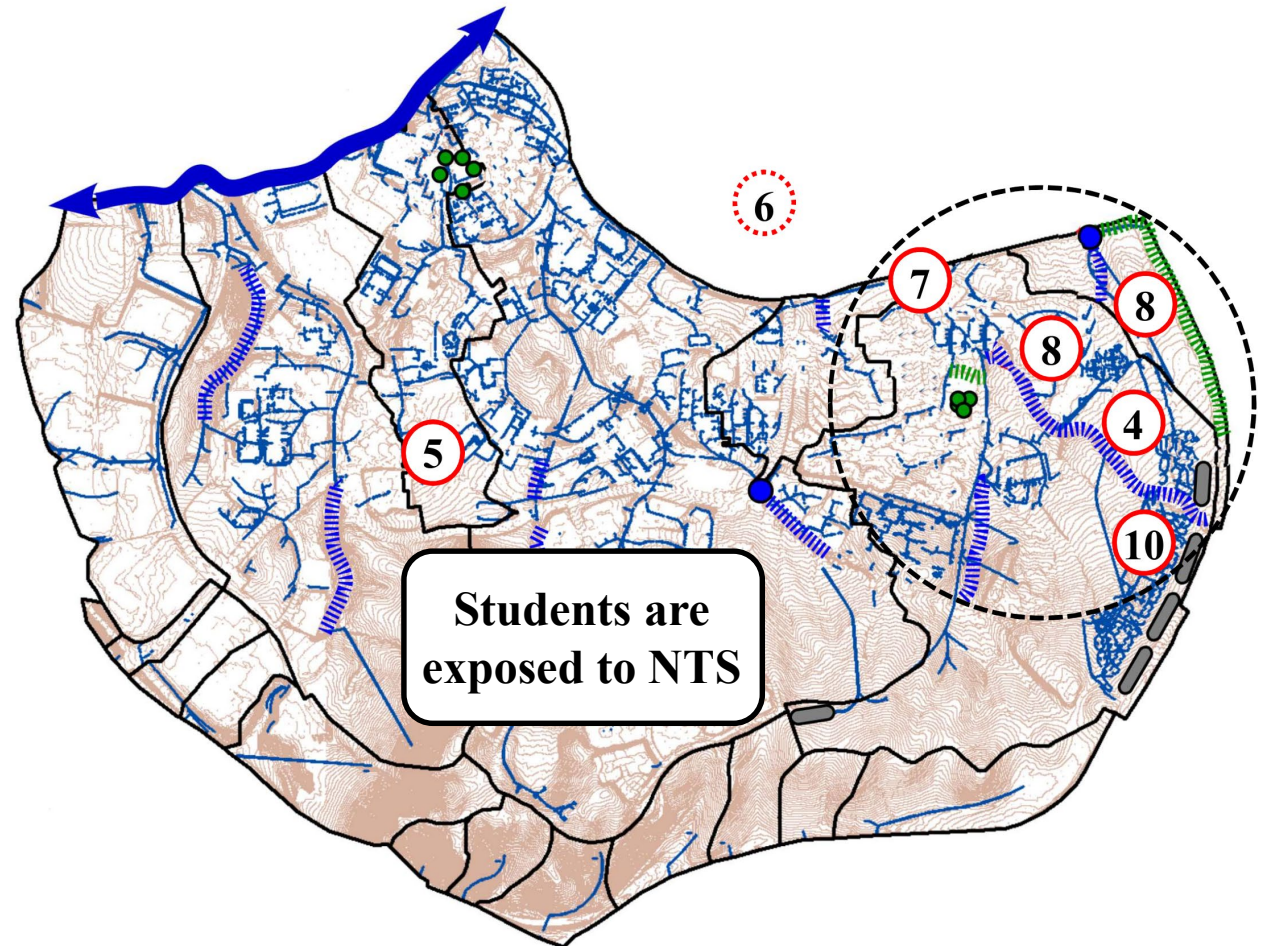
Study Design: *Study Population*

Future NTS Designers

- Civil and Environmental Engineering undergraduate students at the University of California Irvine
- Total surveyed population: 139 students
 - 30% of UCI's CEE undergrads
 - ~100% of UCI's sophomore CEE undergraduate cohort

Many students are housed near NTS in the NE portion of campus
(40% of surveyed students)

- Students have the potential to both see NTS routinely and learn about them as part of course curricula



Study Design: *Survey Instrument*

- The survey was delivered to CEE students on-line through the Canvas learning platform
- Photo survey (12 images from across 5 Southern California UC campuses)
- Multiple landscape types were evaluated so that perceptions NTS could be placed in context with other landscapes that they might replace



Lawns

Gardens

- 1) Palms
- 2) Succulents
- 3) Roses

Native Landscape

- 1) Coastal sage scrub
- 2) Chaparral

Green Infrastructure

- 1) Swales
- 2) Biofilters

Study Design: *Survey Instrument*

Students were asked to determine the degree to which they perceive specific ecosystem services or **disservices** are associated with the landscape in the photo (on a 1-7 scale)

I believe that this system will? (please address each outcome)	Strongly Disagree					Strongly Agree		Don't Know
	1	2	3	4	5	6	7	DK
Cause allergies								
Increase diversity of animals								
Cool down the urban environment								
Attract mosquitos, rats, and other pests								
Make urban landscape more beautiful								
Remove carbon dioxide from the air								
Improve water quality								
Soak up urban runoff, reducing flooding								
Require a lot of water (especially in summer)								
Attract bees, butterflies, and other pollinators								
Provide landscape for relaxation or recreation (<i>walking, picnicking, biking, jogging, cycling, or team sports</i>)								
Reduce the visibility of surrounding areas making people feel less safe								



Study Design: *Survey Instrument - Drivers*

Students were asked to:

- 1) Convey their attitude about each ecosystem service or disservice on a 1-7 scale (1: not important to 7: very important)

Study Design: *Survey Instrument - Drivers*

Students were asked to:

- 1) Convey their attitude about each ecosystem service or disservice on a 1-7 scale (1: not important to 7: very important)
- 2) Answer a series of 10 questions from the New Ecological Paradigm (NEP) scale to evaluate environmental worldviews

Balance of Nature
The balance of nature is strong enough to cope with the impacts of modern industrial nations
The balance of nature is delicate and easily upset
Limits to Growth
We are approaching the limit of the number of people the earth can support
The earth is like a spaceship with very limited room and resources
Anti-anthropocentrism
Plants and animals have as much right as humans to exist
Humans were meant to rule over the rest of nature
Human exemptionalism
Human ingenuity will ensure that we do not make the earth unlivable
Humans will eventually learn enough about how nature works to be able to control it
Ecocrises
The so-called "ecological crisis" facing humankind has been greatly exaggerated
If things continue on their present course, we will soon experience a major ecological catastrophe

Study Design: *Survey Instrument - Drivers*

Students were asked to:

- 1) Convey their attitude about each ecosystem service or disservice on a 1-7 scale (1: not important to 7: very important)
- 2) Answer a series of 10 questions from the New Ecological Paradigm (NEP) scale to evaluate environmental worldviews
- 3) Answer a series of environmental and engineering knowledge questions assessing theoretical, experiential, and procedural knowledge

Theoretical

- Biodiversity
- Urban runoff (define, water quality problem, treated prior to discharge)
- NTS
- Native landscapes

Experiential

- Seen NTS on campus
- Seen native landscapes on campus

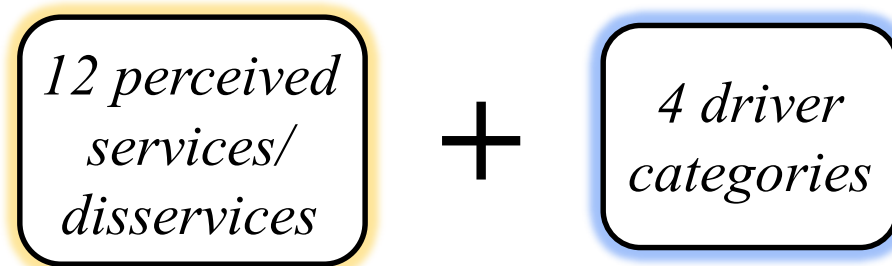
Procedural

- Can correctly identify NTS as NTS
- Can correctly identify native landscapes as native

Study Design: *Survey Instrument - Drivers*

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- 2) Answer a series of 10 questions from the New Ecological Paradigm (NEP) scale to evaluate environmental worldviews
- 3) Answer a series of environmental and engineering knowledge questions assessing theoretical, experiential, and procedural knowledge
- 4) Provide demographic information (race, ethnicity, gender, age, country of origin, and academic major)



Outline

- **Study Design**
 - study population: *next generation of NTS designers*
 - survey techniques
- **Perceived services and disservices of NTS for urban stormwater**
 - benchmark relative to other urban landscapes (*lawns, gardens, remnant native landscapes*)
 - multifunctional services/disservices bundles (co-associated services/disservices)
- **Drivers of landscape perceptions** (knowledge, attitudes about services/disservices, environmental worldviews, demographics)
- **Implications for the future**

Dominant patterns in urban landscape perception

(co-associated services and disservices)

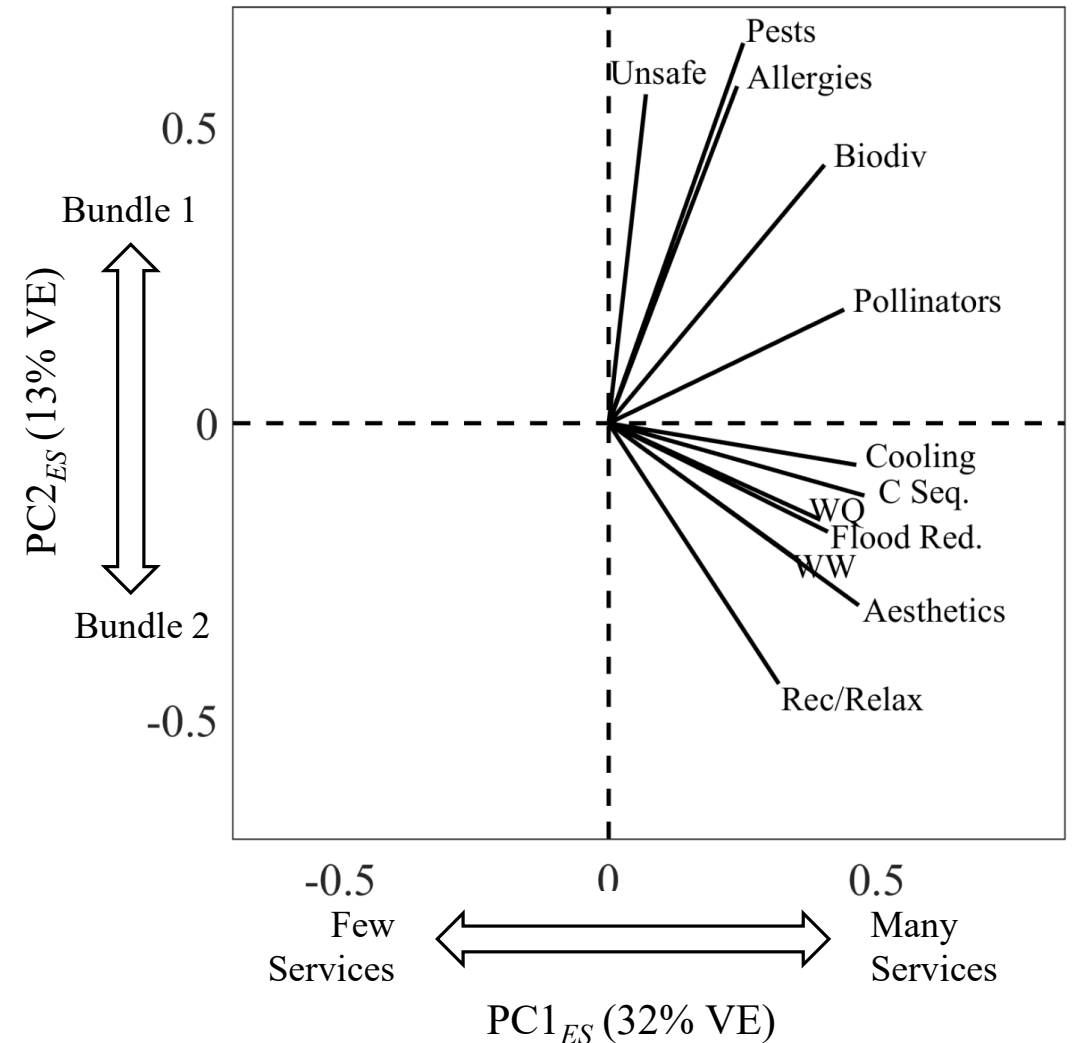
Principal Component Analysis of student perceptions *(2 significant patterns – 45% VE)*

1) $PC1_{ES}$: Landscapes provide many services vs few

2) $PC2_{ES}$: Landscapes provide primarily

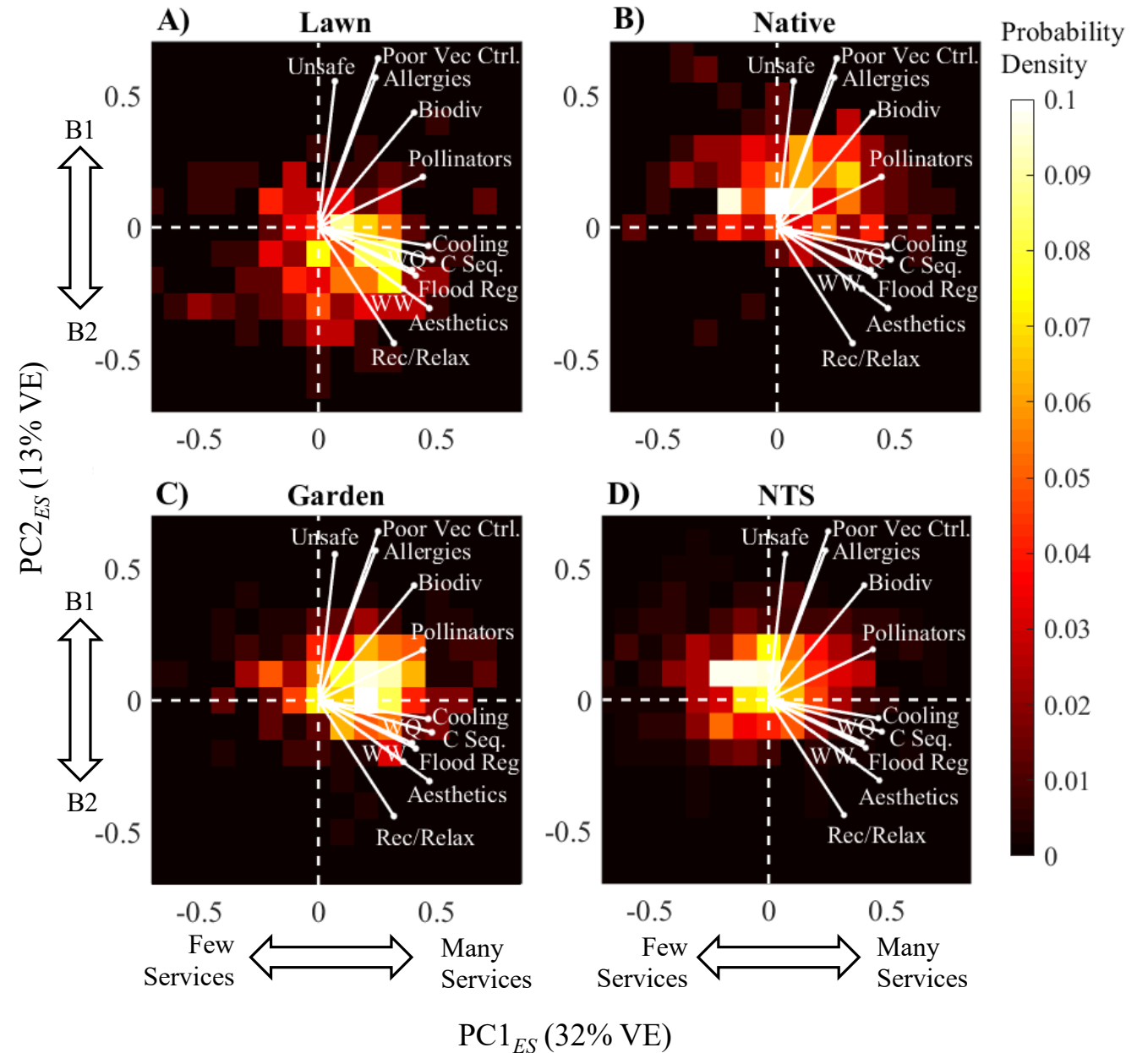
bundle 1 services/disservices *(organism-associated services/disservices and lack of safety)* or

bundle 2 services/disservices *(regulating & cultural services as well as water waste)*



Urban landscapes were perceived as multifunctional
different landscapes provide different (characteristic) suites of services/disservices – they are perceived differently

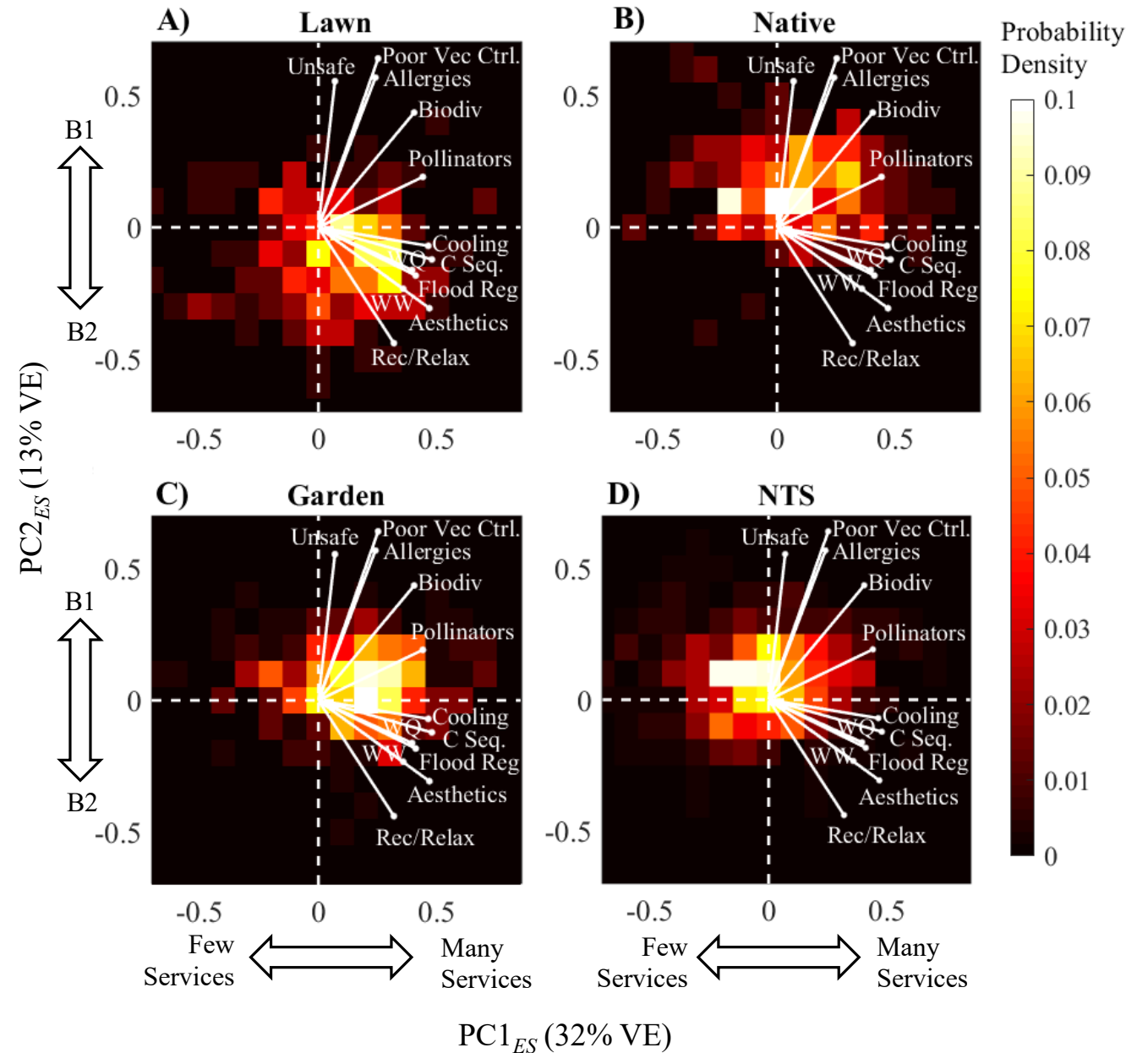
Color: probability that individuals perceive a given landscape provides specific services or disservices



Urban landscapes were perceived as multifunctional

different landscapes provide different (characteristic) suites of services/disservices – they are perceived differently

Lawns are perceived to provide many services (primarily bundle 2): *regulating and cultural services but not organism-associated services/disservices*

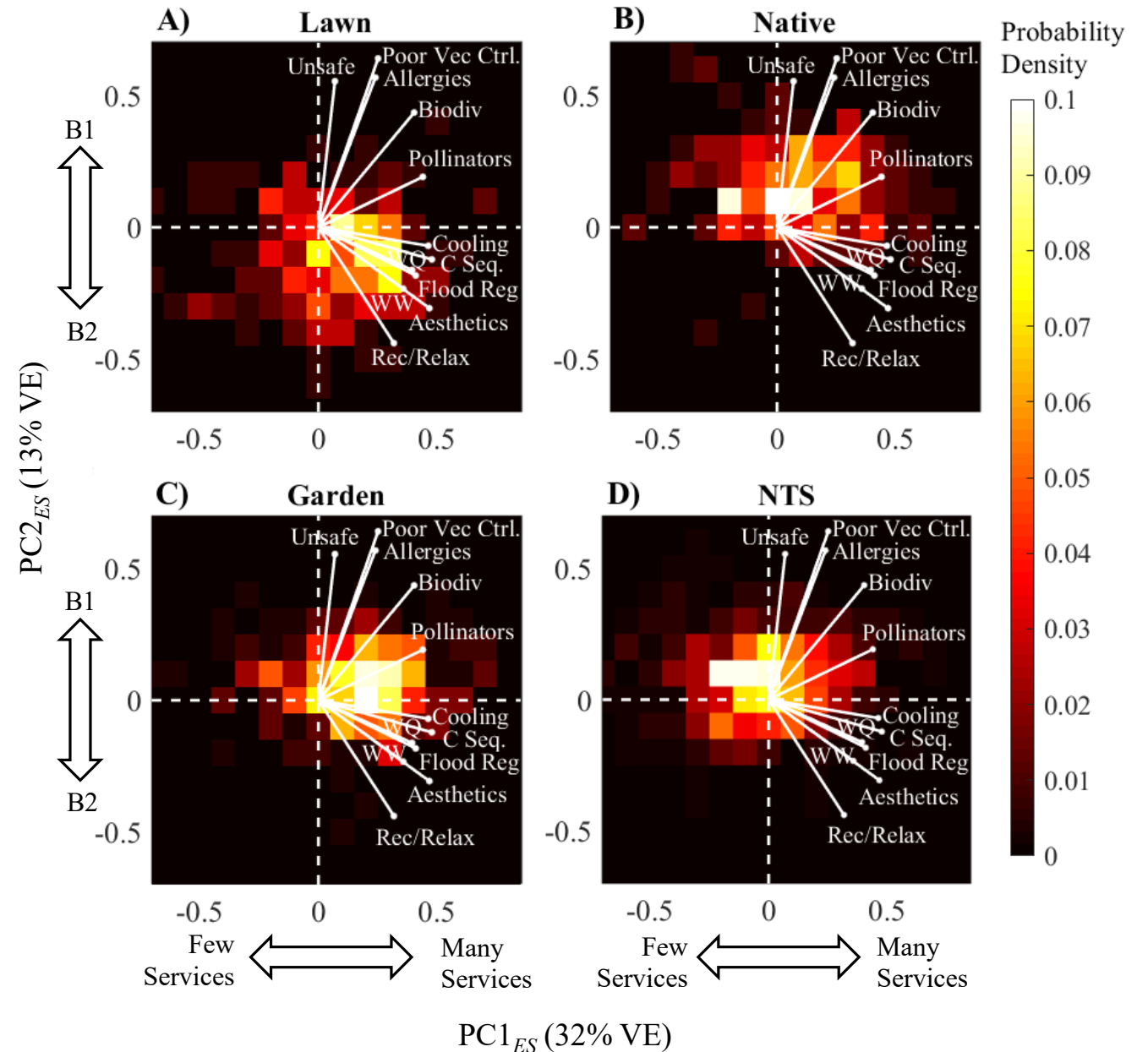


Urban landscapes were perceived as multifunctional

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Native landscapes are split about PC1 (*some individuals feel they provide many services and others feel they provide few*).

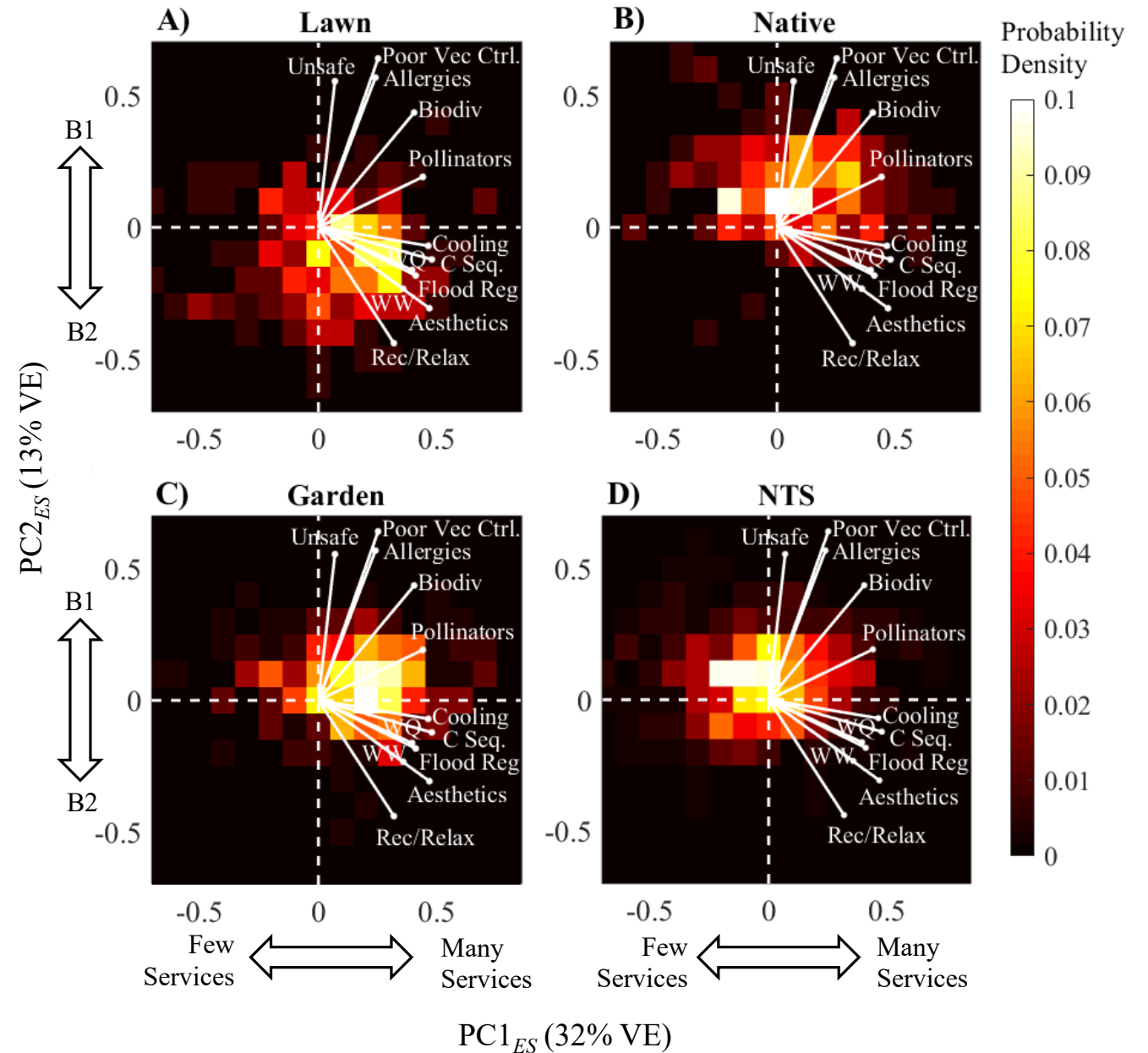
If they provide services or disservices, they are those from bundle 1



Urban landscapes were perceived as multifunctional

(different landscapes providing different services and disservices)

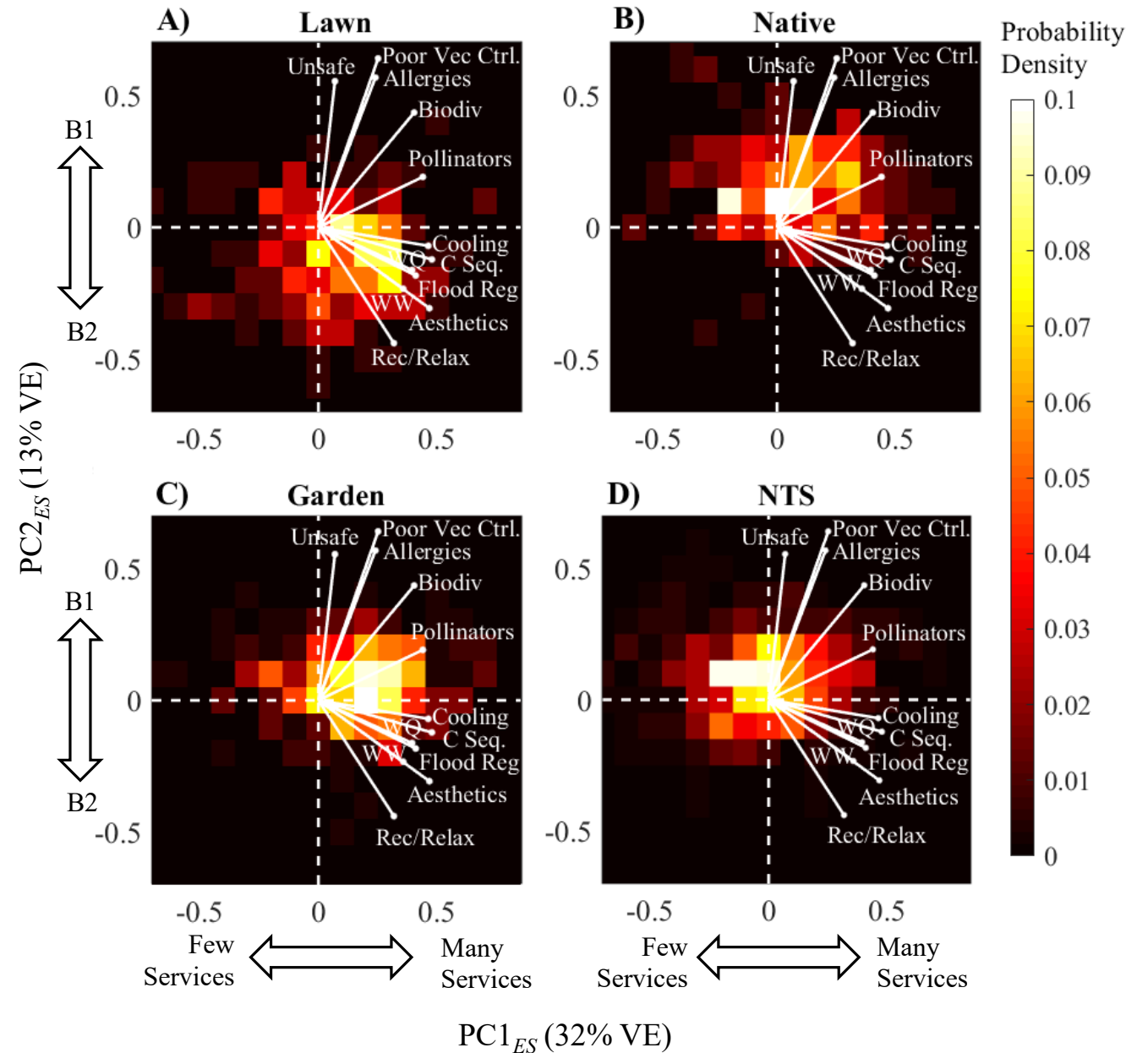
Gardens are perceived as intermediate between lawns and native landscapes
(provide many services from both bundle 1 and bundle 2)



Urban landscapes were perceived as multifunctional

(different landscapes providing different services and disservices)

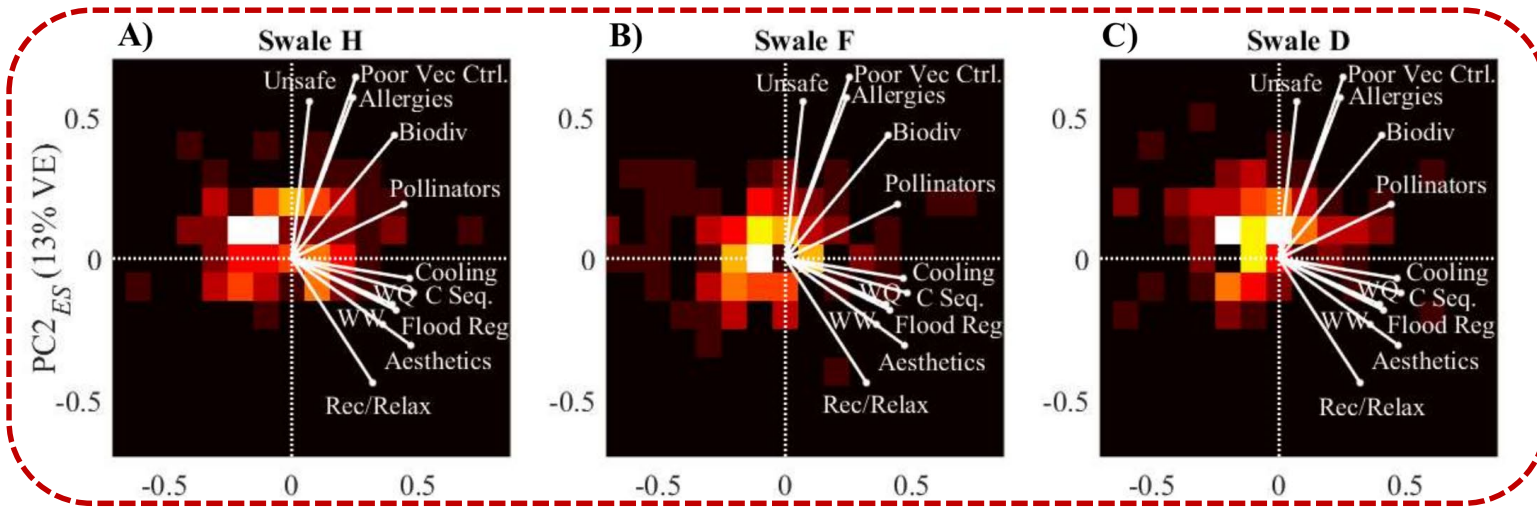
NTS are more variously perceived, which may suggest limited social norming



Outline

- **Study Design**
 - study population: *next generation of NTS designers*
 - survey techniques
- **Perceived services and disservices of NTS for urban stormwater**
 - benchmark relative to other urban landscapes (*lawns, gardens, remnant native landscapes*)
 - multifunctional services/disservices bundles (co-associated services/disservices)
- **What drives variability in how urban landscapes are perceived** (knowledge, attitudes about services/disservices, environmental worldviews, demographics)
- **Implications for the future**

NTS Perceptions: *Physical Drivers (Siting and Design)*

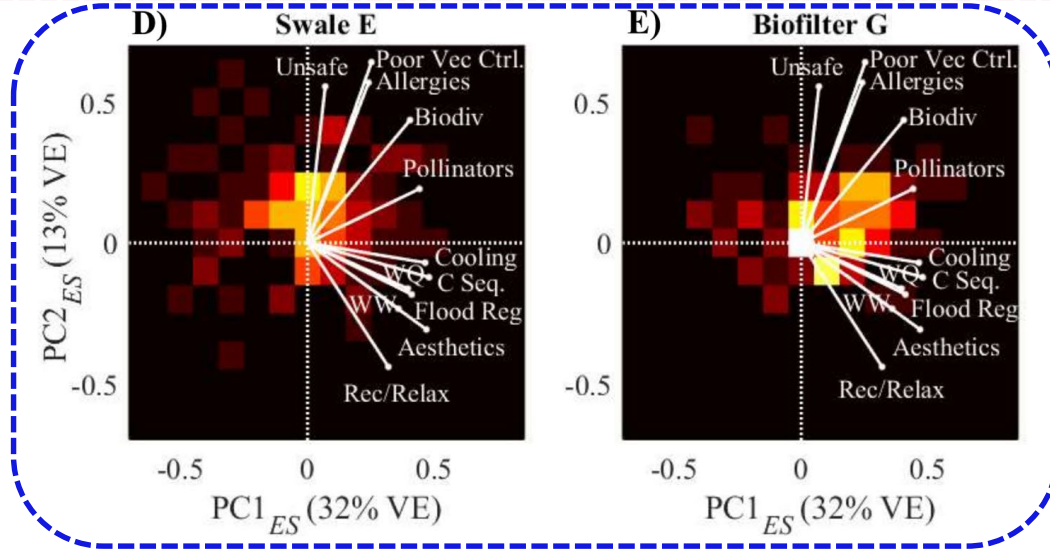


Few services or disservices



Siting/Design Elements:

- Sited near roads
- Prominent curbs/gutter elements



Moderate to many services & disservices

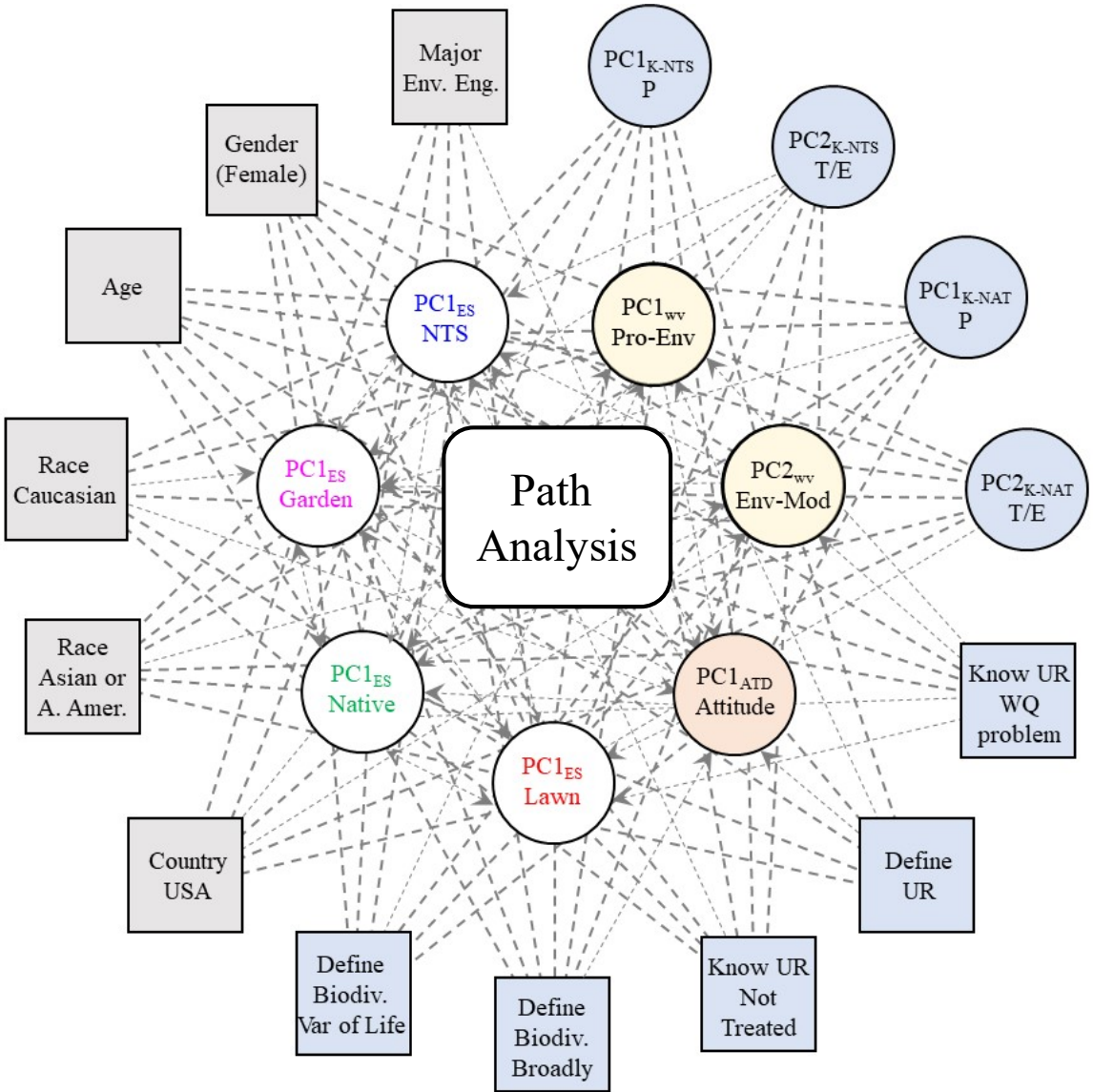


Siting/Design Elements:

- Sited near buildings
- No prominent engineering design elements



Social Drivers of Variability in Perceived Landscape Services/Disservices



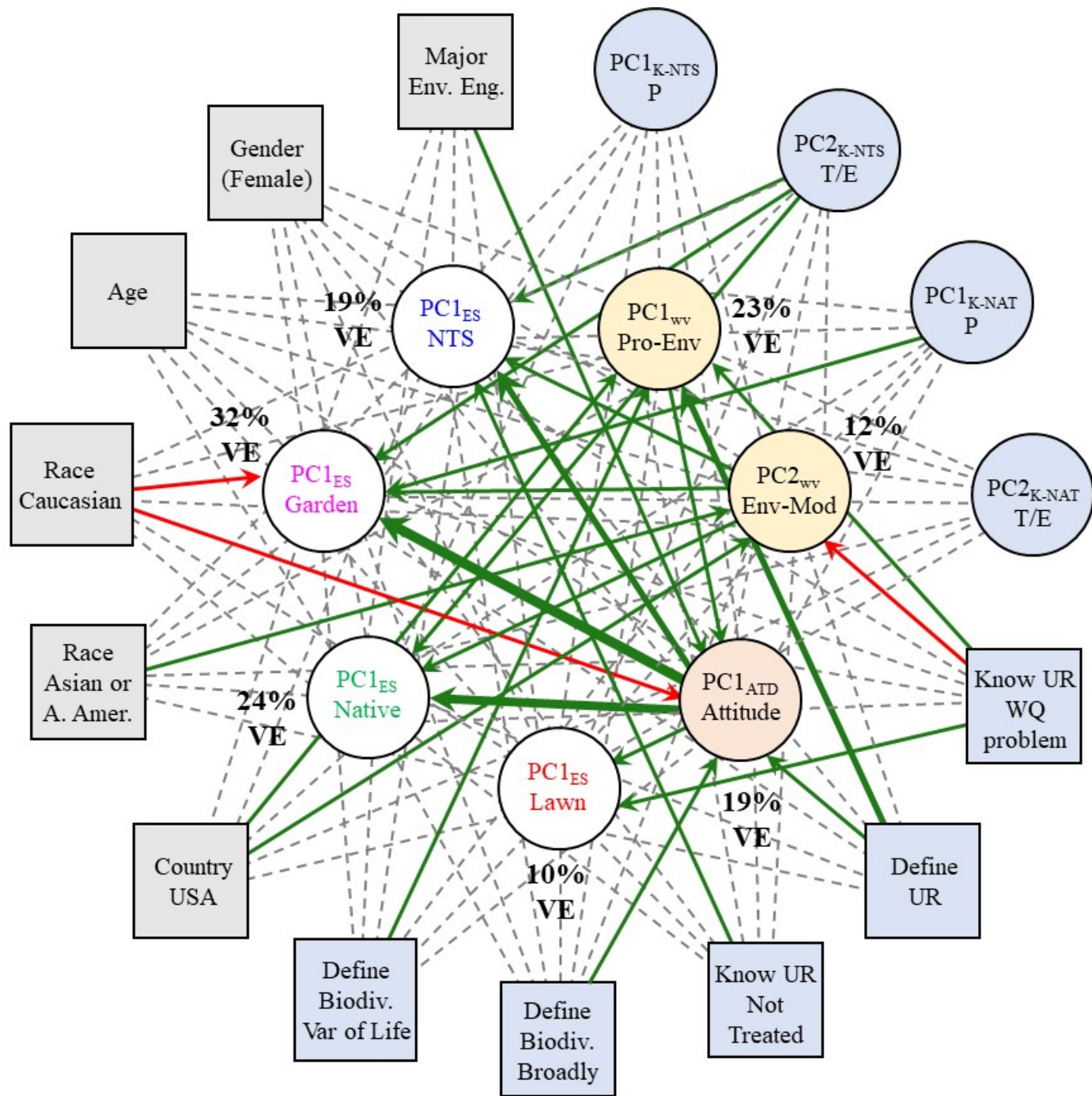
Demographics

Knowledge
 - biodiversity
 - urban runoff
 - native landscapes
 - NTS

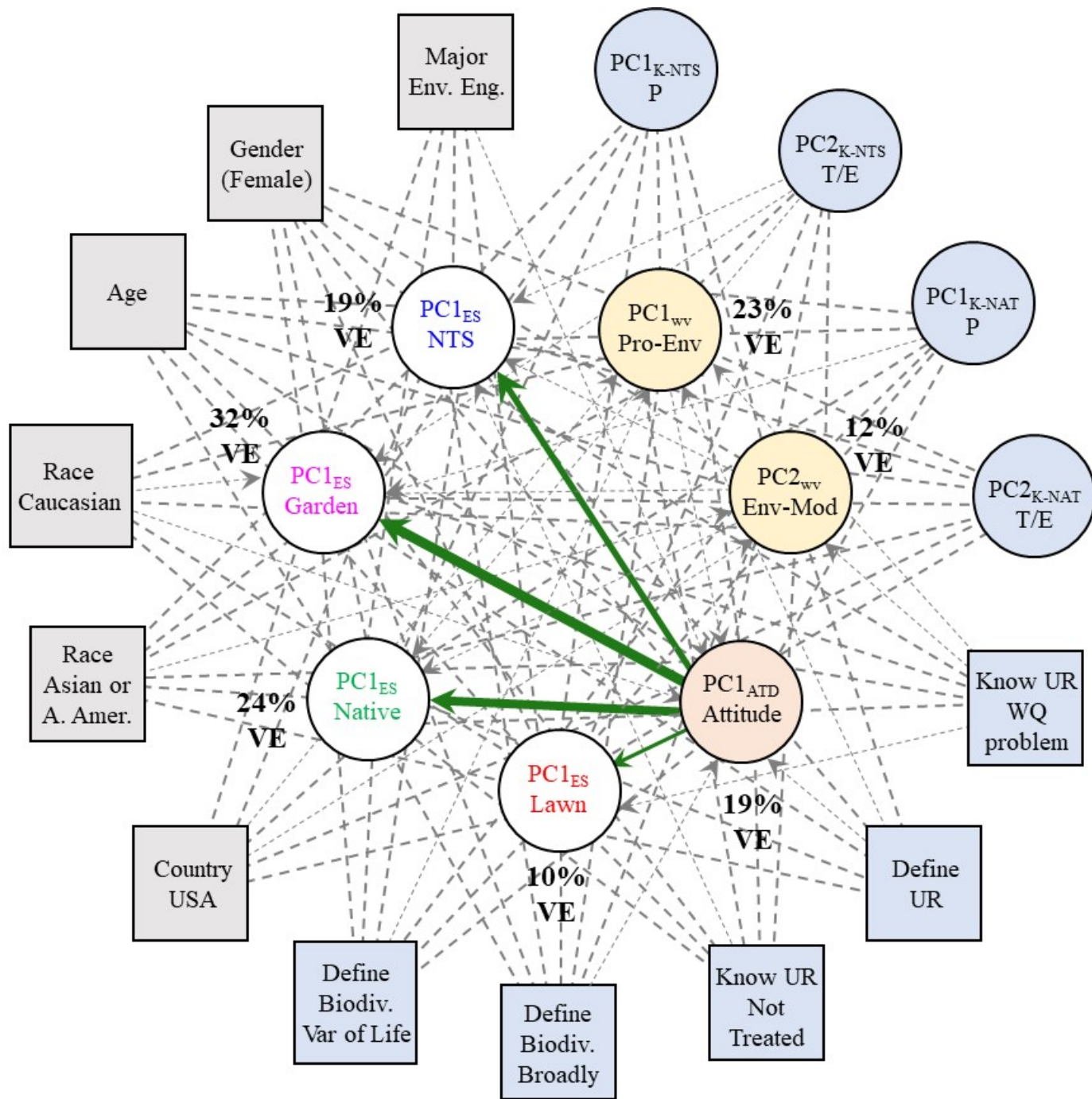
Environmental worldviews

Attitude about ecosystem services

Landscape Perceptions
(many services vs few)



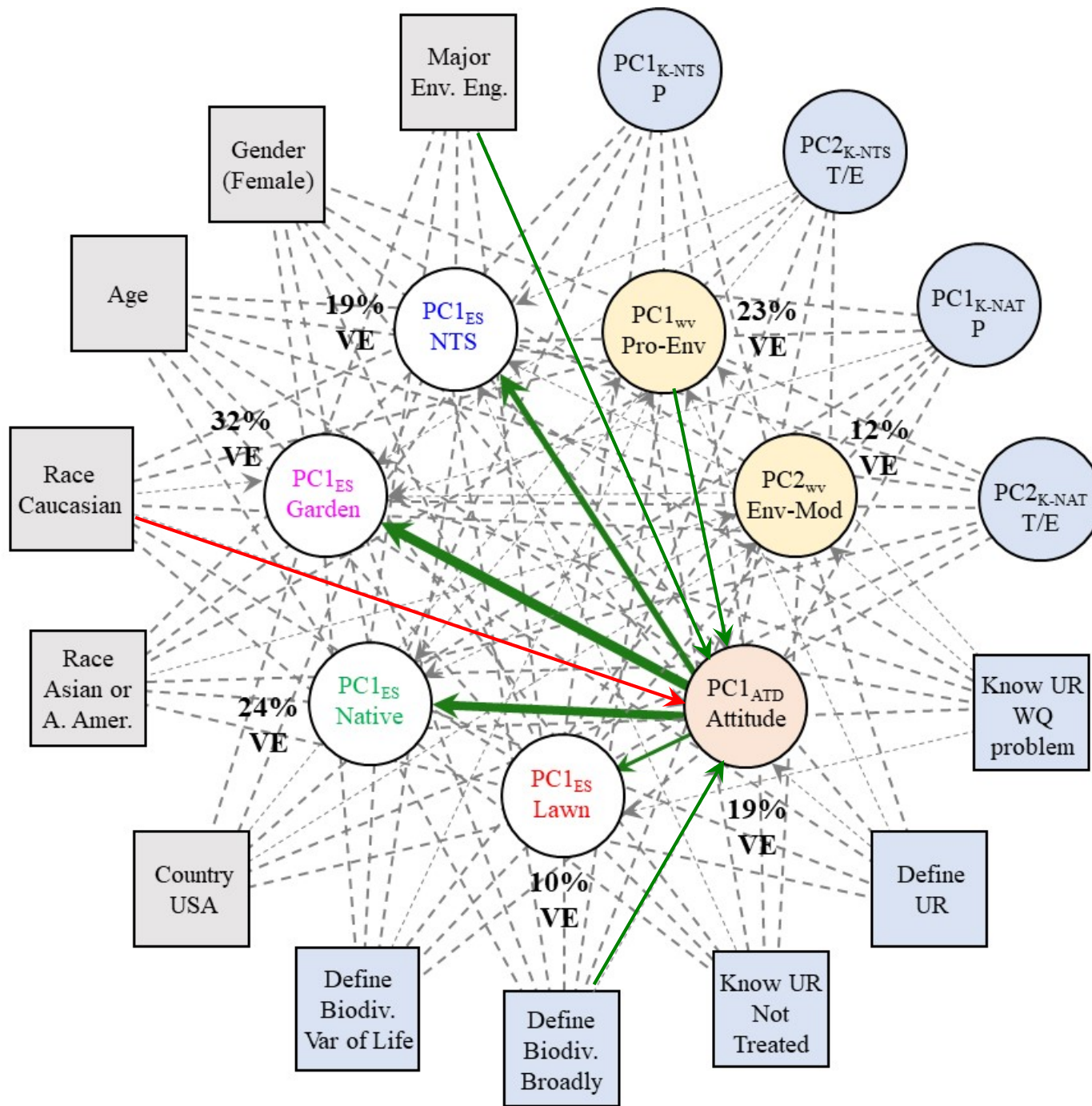
Demographics, knowledge, worldviews, and attitudes all shape landscape perceptions (10-32% VE)



Attitudes about ecosystem services were the strongest predictor of perceived services provisioning

- individuals that thought services were important were more likely to feel landscapes provide many services

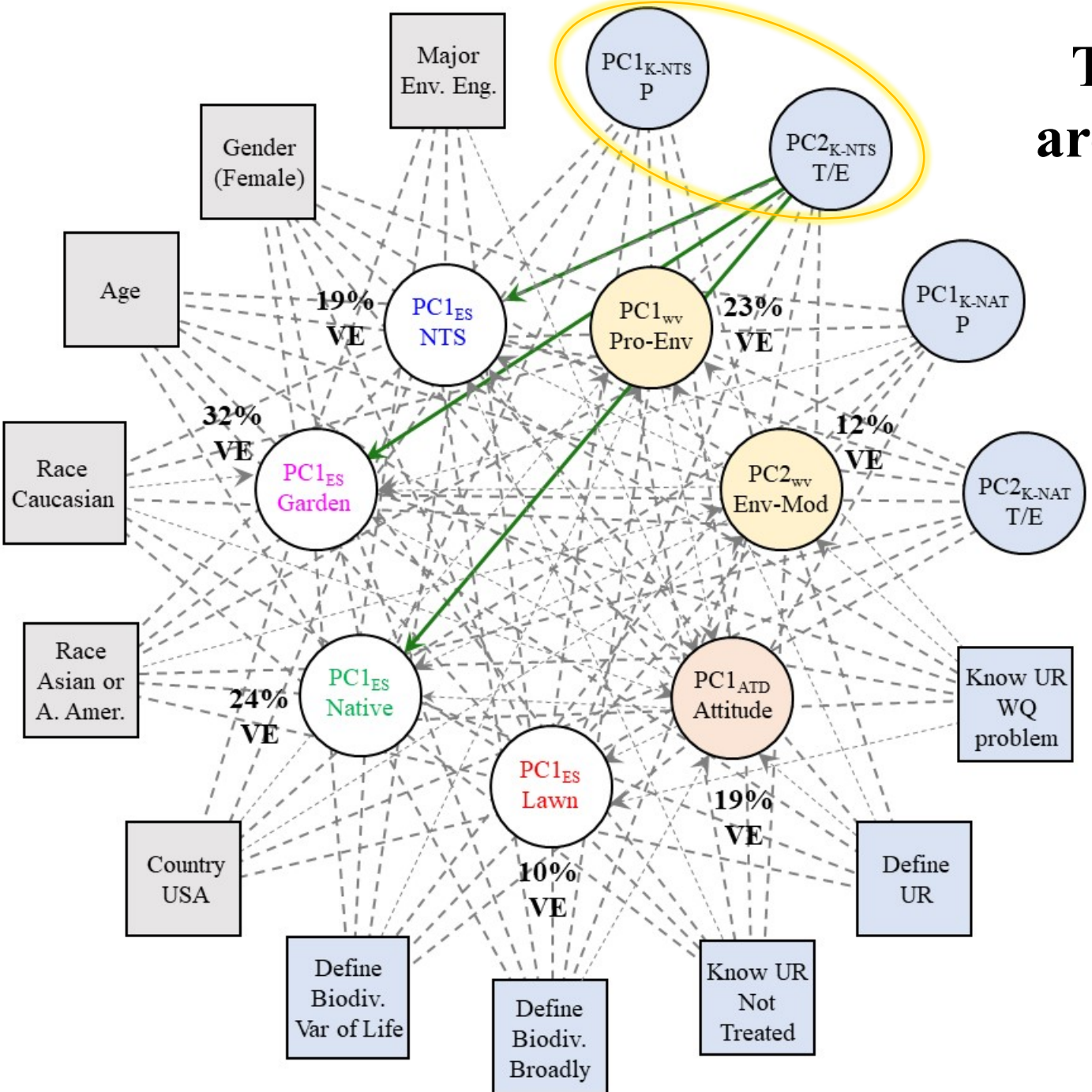
Consistent with other literature linking attitudes about specific landscape features or concepts to landscape preferences (*first time this has been shown for NTS*)



Attitudes were a function of academic major, knowledge about biodiversity, environmental worldviews & race

- Individuals that identified racially as Caucasian were less likely to have a positive attitude about services
- Individuals that were environmental engineering majors, had a pro-environmental worldview, and a broad understanding of biodiversity were more likely to have a positive attitude about services

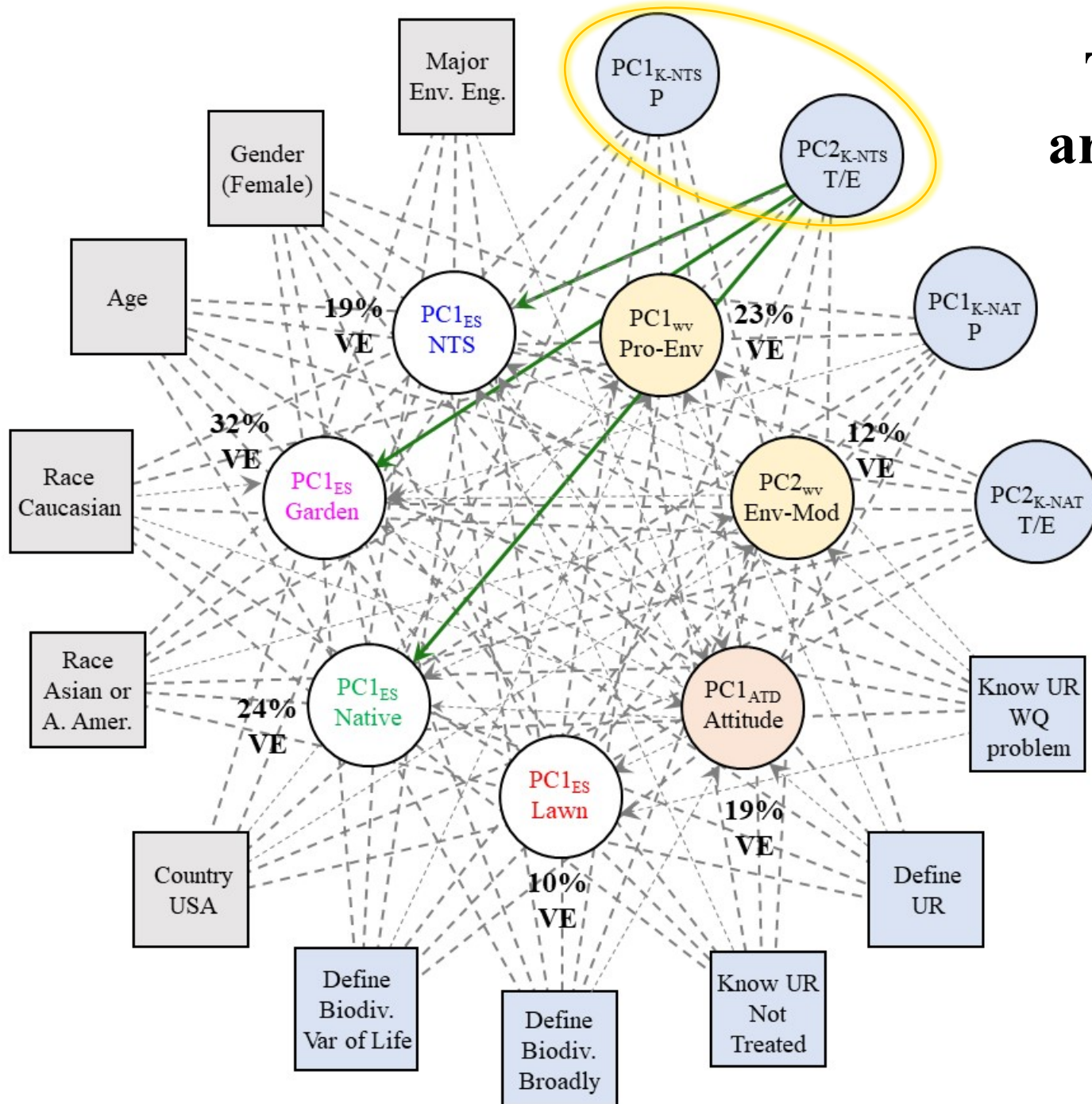
The relationships we don't see are as informative as those we do



Knowledge about NTS was an inconsistent driver of landscape perceptions

- Individuals with factual and experiential knowledge of NTS were more likely to think urban landscapes provide services to people
- Procedural knowledge of NTS (the capacity to discriminate NTS from other landscapes) did not influence perceived services provisioning

The relationships we don't see are as informative as those we do



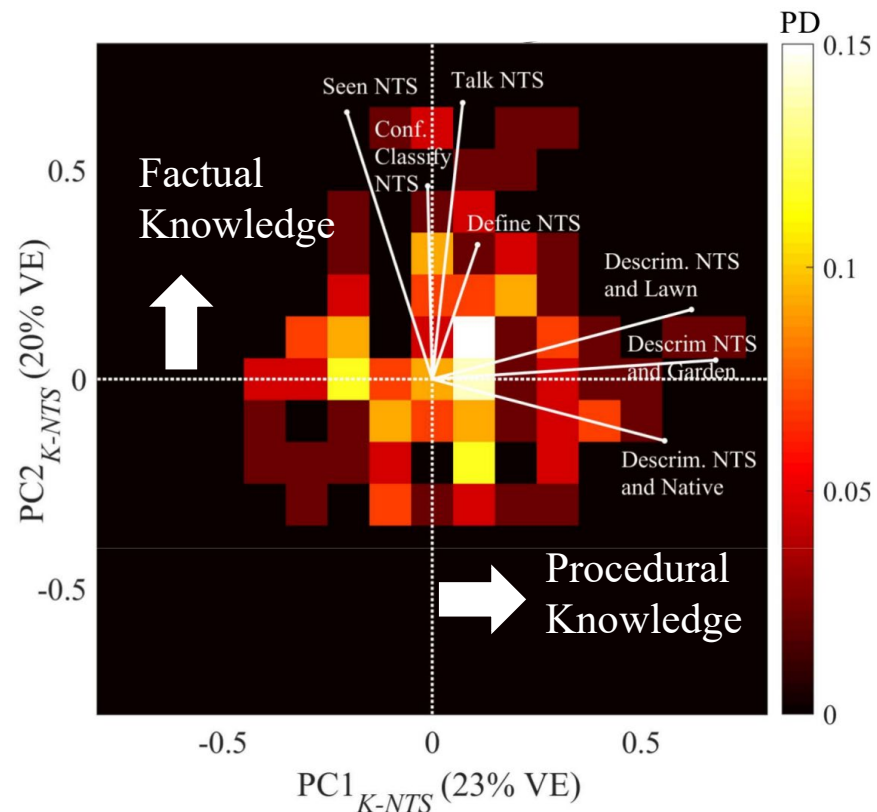
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Does not necessarily mean that knowing what you see is not important

Engineering students had difficulty recognizing NTS in situ

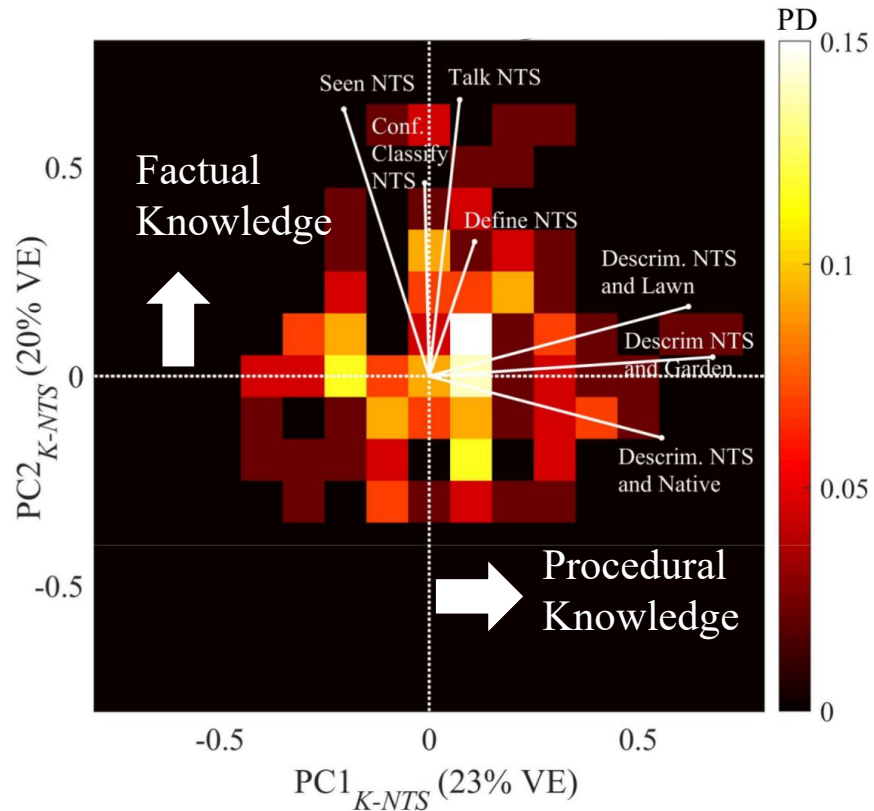
- **Engineering students had very limited capacity to identify NTS** (*only ~30% of individuals identified NTS as NTS more often than they misidentified other landscapes as NTS*)
- **Generally uncertain about the accuracy of their landscape classifications** (*~3 on a scale of 1: not certain to 7: very certain*)



Factual knowledge about NTS was orthogonal to procedural knowledge suggesting that students have difficulty translating their factual understanding of NTS into rules or procedures for identifying them

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- **Engineering students had very limited capacity to identify NTS** (*only ~30% of individuals identified NTS as NTS more often than they misidentified other landscapes as NTS*)
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Factual knowledge about NTS was orthogonal to procedural knowledge suggesting that students have difficulty translating their factual understanding of NTS into rules or procedures for identifying them

Highlights a gap in our current efforts to educate the next generation of NTS designers
(contextual understanding)

Conclusions

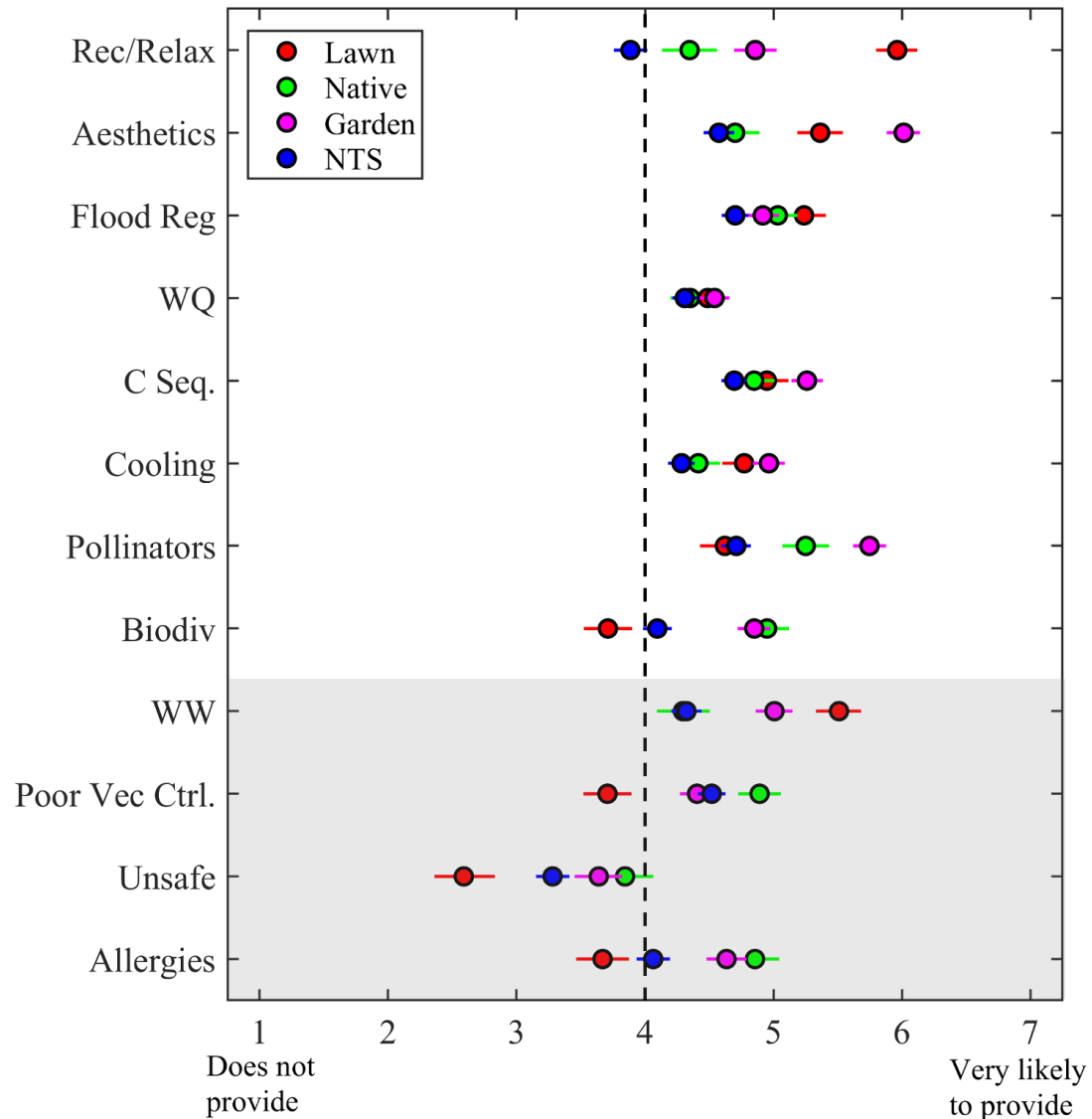
Public perception surveys coupled with dimensionality reduction techniques and simple network models are really powerful tools for helping us understand urban landscape preferences and their drivers

- Urban landscapes were perceived as multifunctional, providing characteristic suites of services and disservices
- NTS were more variously perceived than other landscapes (*low familiarity and limited social norming*)

Physical landscape characteristics (*siting and design*) and social drivers (*attitudes about ecosystem services, environmental worldviews, knowledge, and demographics*) all influenced perceived landscape services

- Certain variables (procedural knowledge of NTS) influenced perceived landscape services less than anticipated, and may point to a knowledge gap in the training of future landscape professionals

Average Landscape Perceptions



Most landscapes were perceived to provide all services and some disservices to varying degrees (*no landscape was perceived to be unsafe*)

- **NTS** were perceived to provide fewer services than other landscapes (*includes traditional NTS services like water quality and flood regulation*)
- **Gardens** were perceived to provide more services than other landscapes
- **Native landscapes** were perceived to provide more disservices than other landscapes (*excepting water waste which was perceived to be highest for **lawns***)