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Integrating Research and Education: Education at the Speed of Research

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Northwest Advanced Renewables Alliance

SUPPLY CHAIN

FRP

FOREST RESIDUES PREPARATION

Primary feedstock targets include forest residues from logging and thinning operations. We are also considering mill residues and discarded woody material from construction and demolition, in regions where these materials are under utilized.

T

TRANSPORTATION

Feedstocks are transported from the collection site to a conversion facility. Chipping can take place at the loading or in a preprocessing facility.

PT

PRE-TREATMENT

Wood chips are treated to make the sugar polymers (polysaccharides) accessible to degrading enzymes. These processes allow the lignin to be available for separation.

EH

ENZYMATIC HYDROLYSIS

Specific enzymes are added to hydrolyze (cleave) the polysaccharides and generate simple sugars (monosaccharides).

F

FERMENTATION

Specialized yeast convert the monosaccharides into isobutanol.

BCP

BIOJET & CO-PRODUCTS

Aviation fuels can be generated from the platform molecules derived from wood sugars. Lignin can be used to generate co-products such as epoxies, structural materials and bio-based plastics. As an alternative, lignin can be burned to produce renewable energy.

ONE BONE DRY **TON** WOODY BIOMASS + DIESEL + HEAT, WATER, & CHEMICALS = **~600** POUNDS LIGNIN AND **~59** GALLONS ISOBUTANOL OR **~42** GALLONS BIOJET

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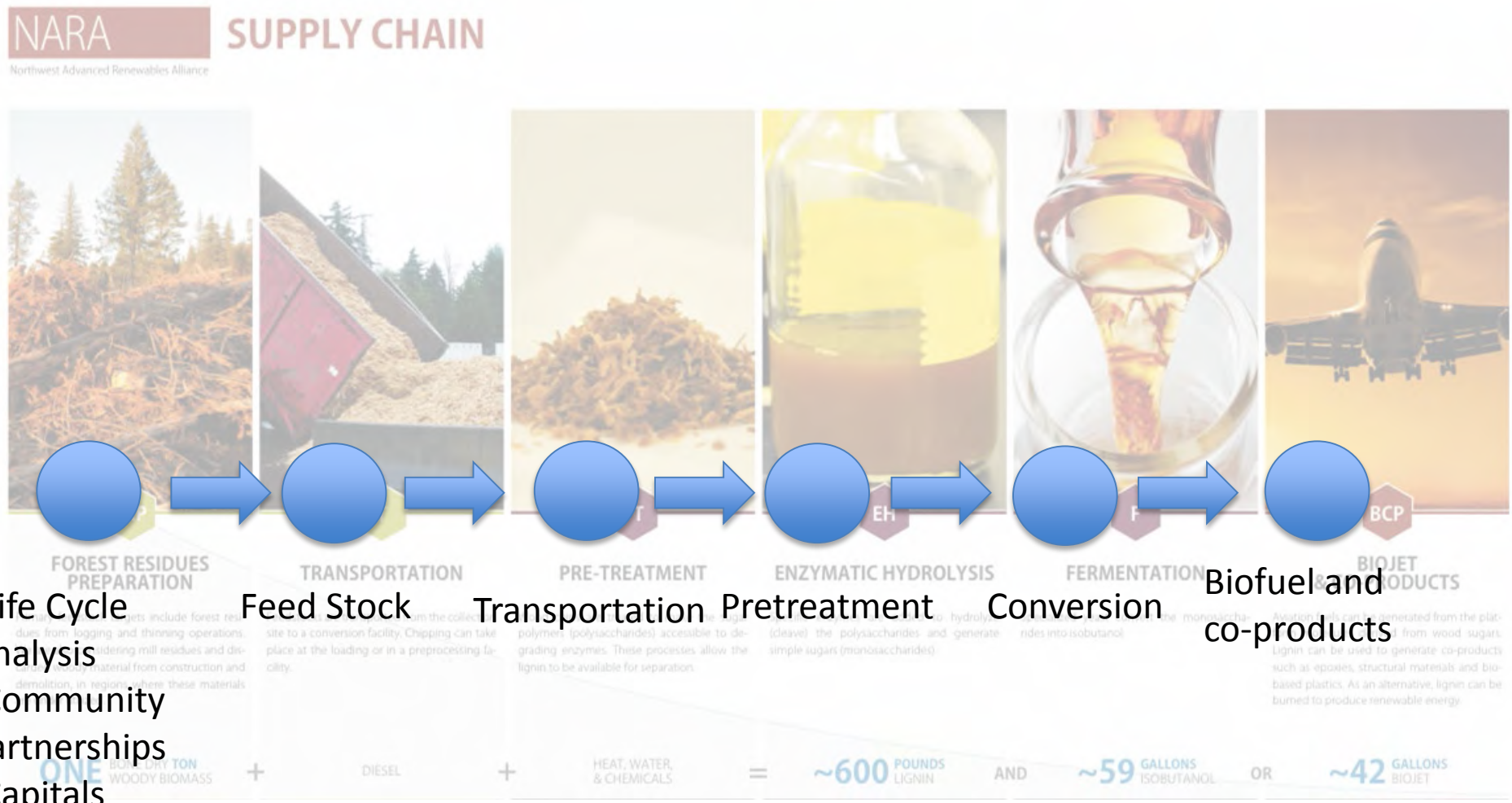
Flow for Education and Outreach of NARA research



-Life Cycle Analysis
-Community Partnerships
-Capitals Framework

Feed Stock

Transportation

Pretreatment

Conversion

Biofuel and co-products

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Flow for Education and Outreach of NARA research

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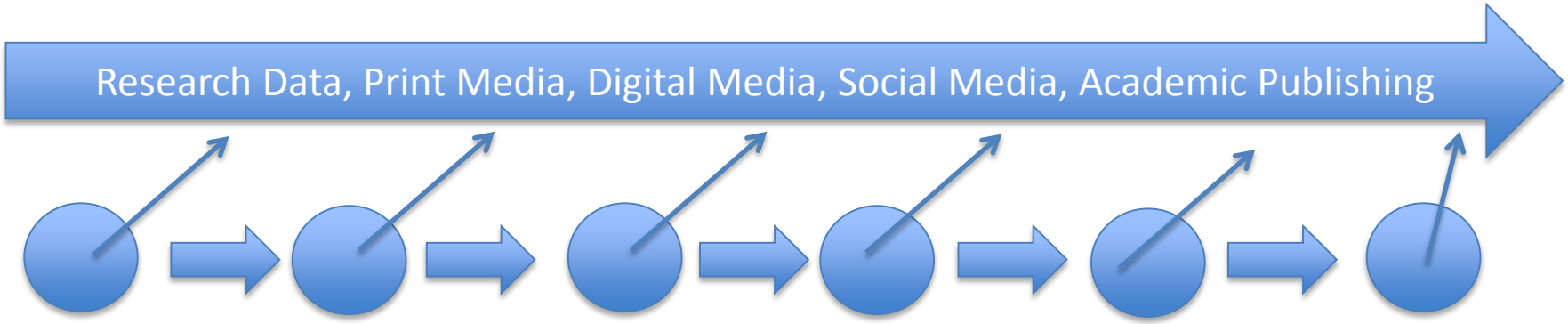

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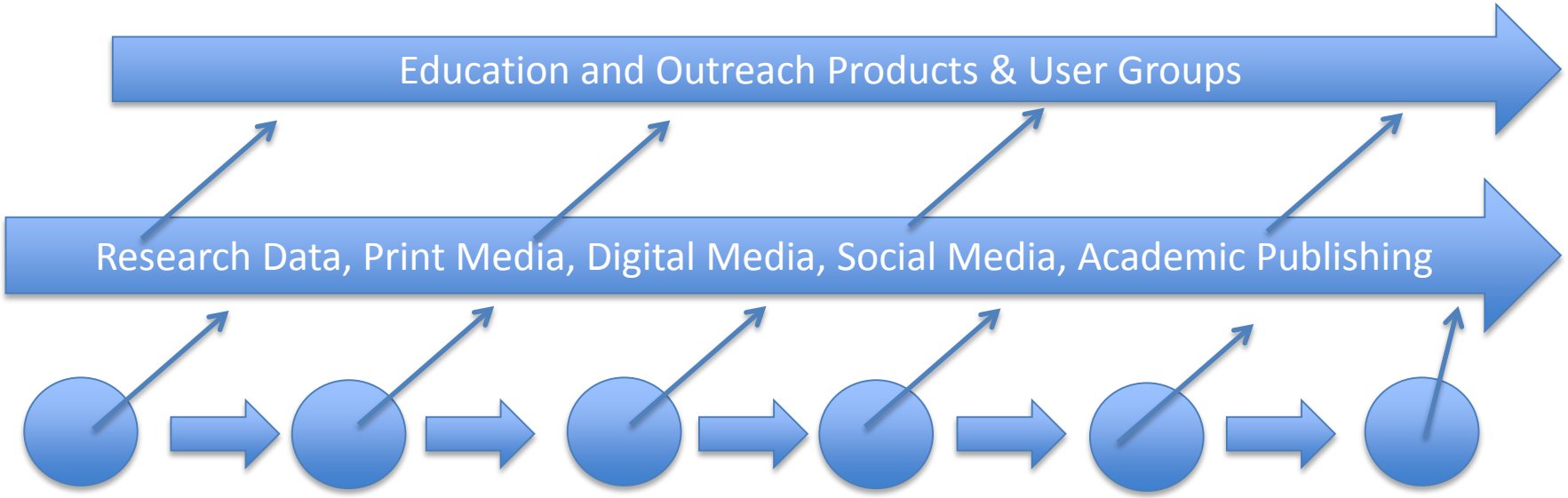

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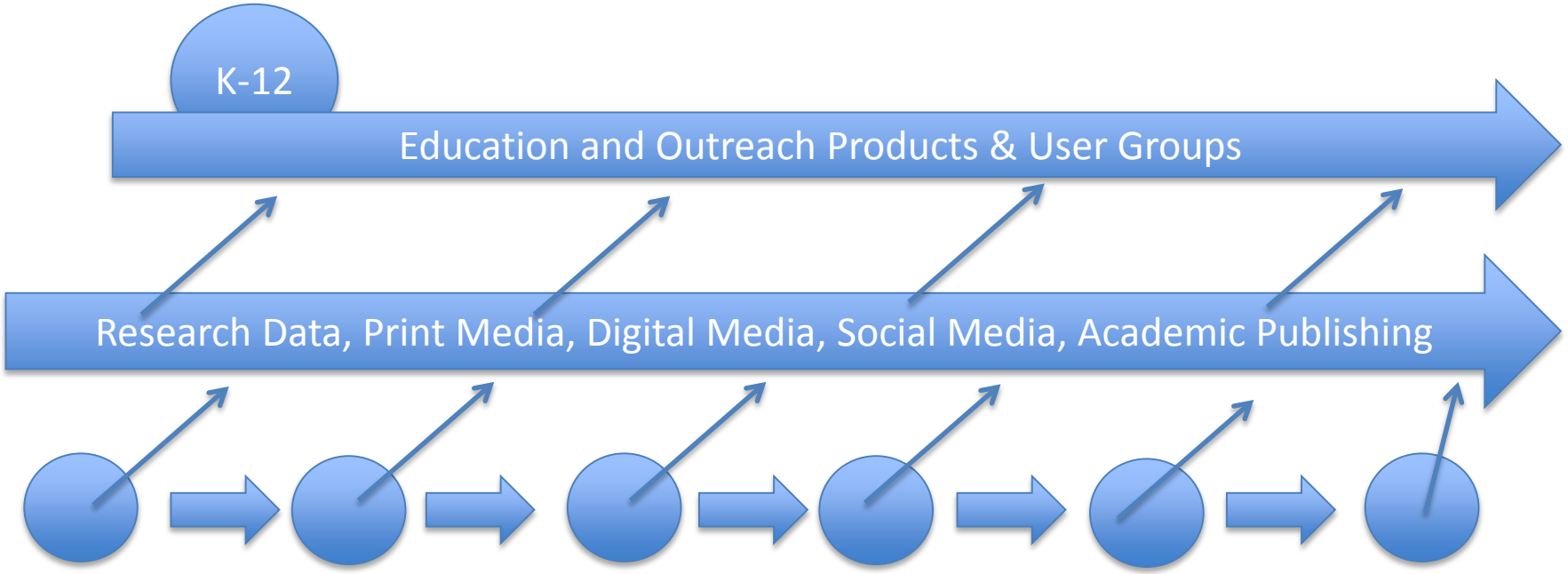

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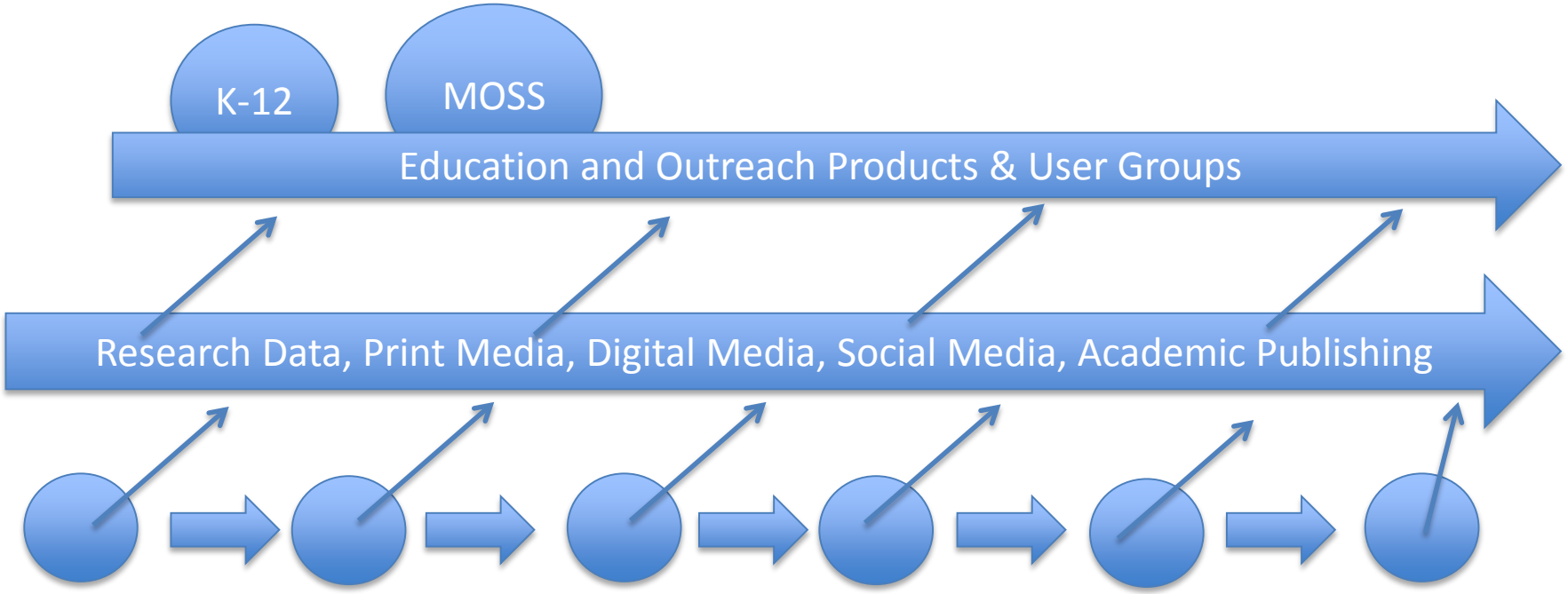

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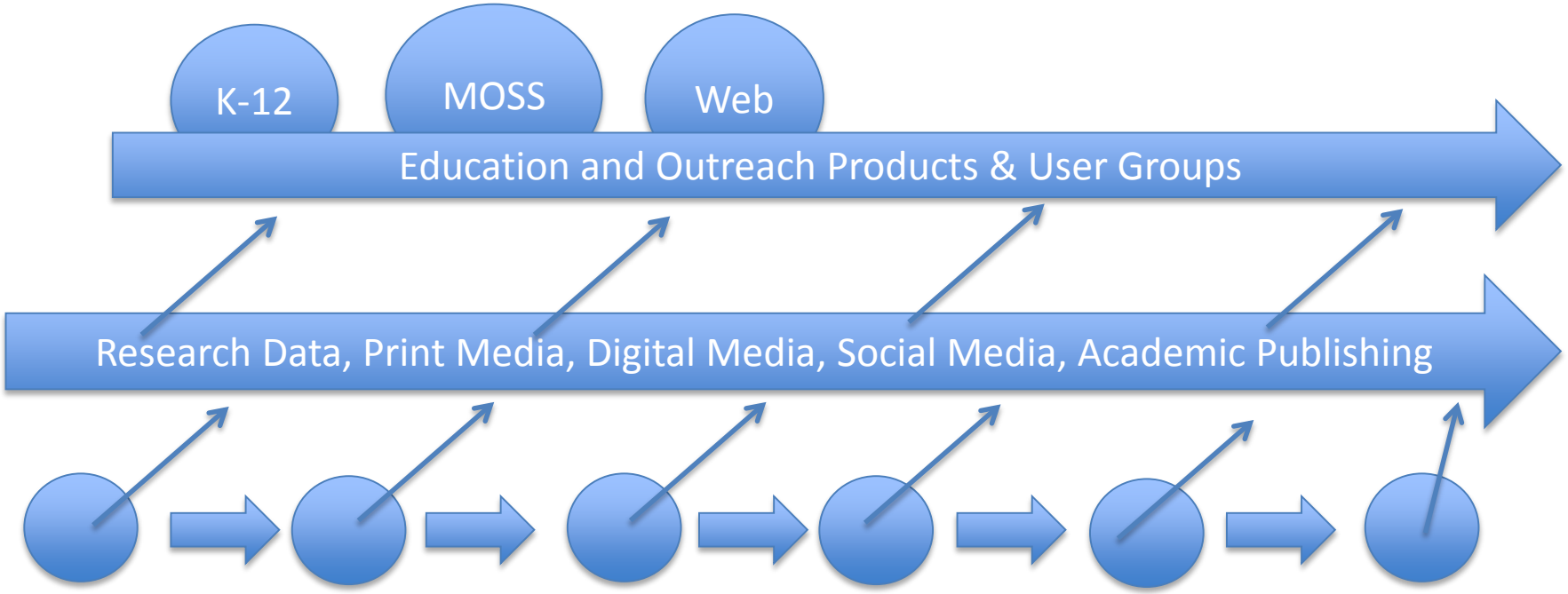

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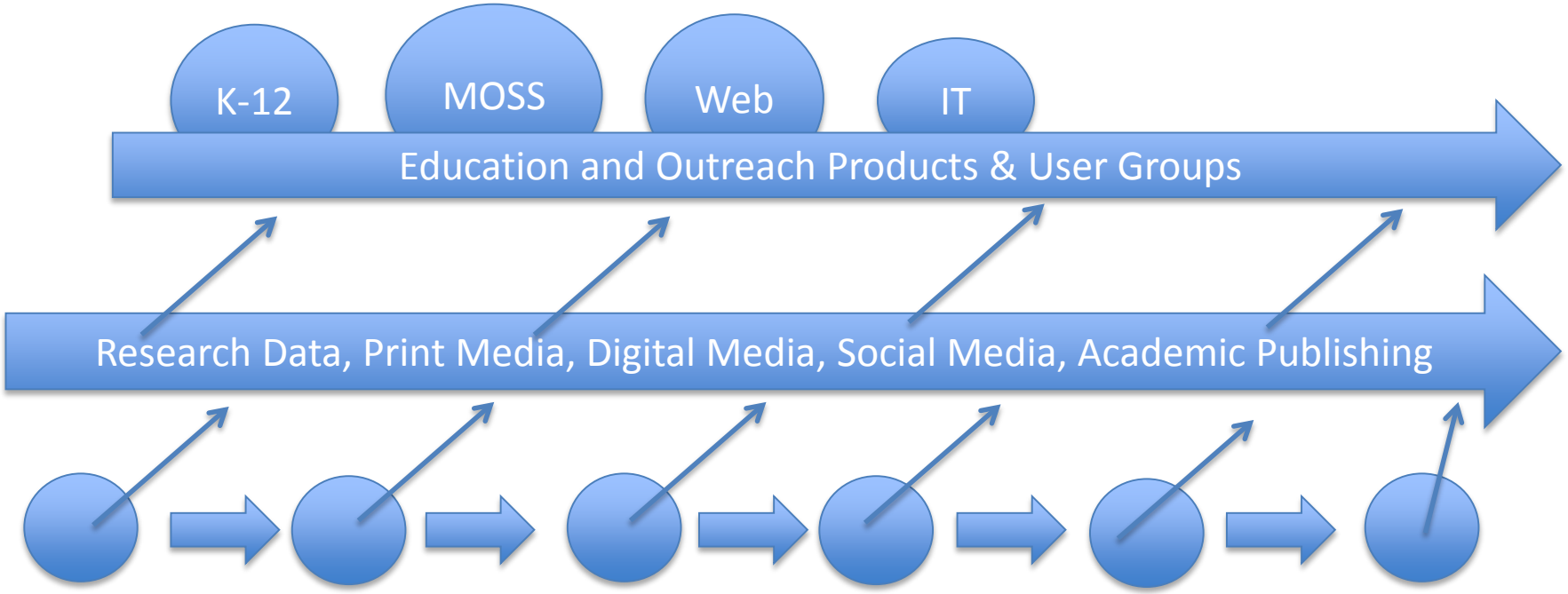

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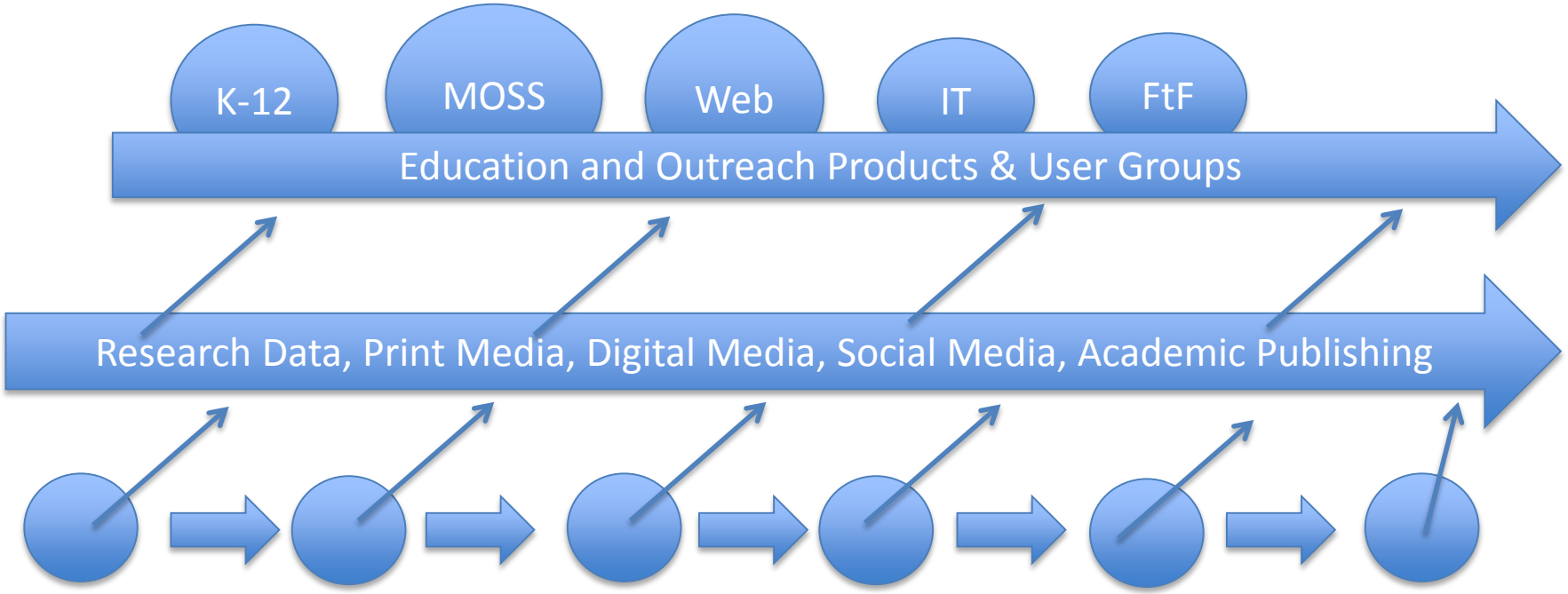

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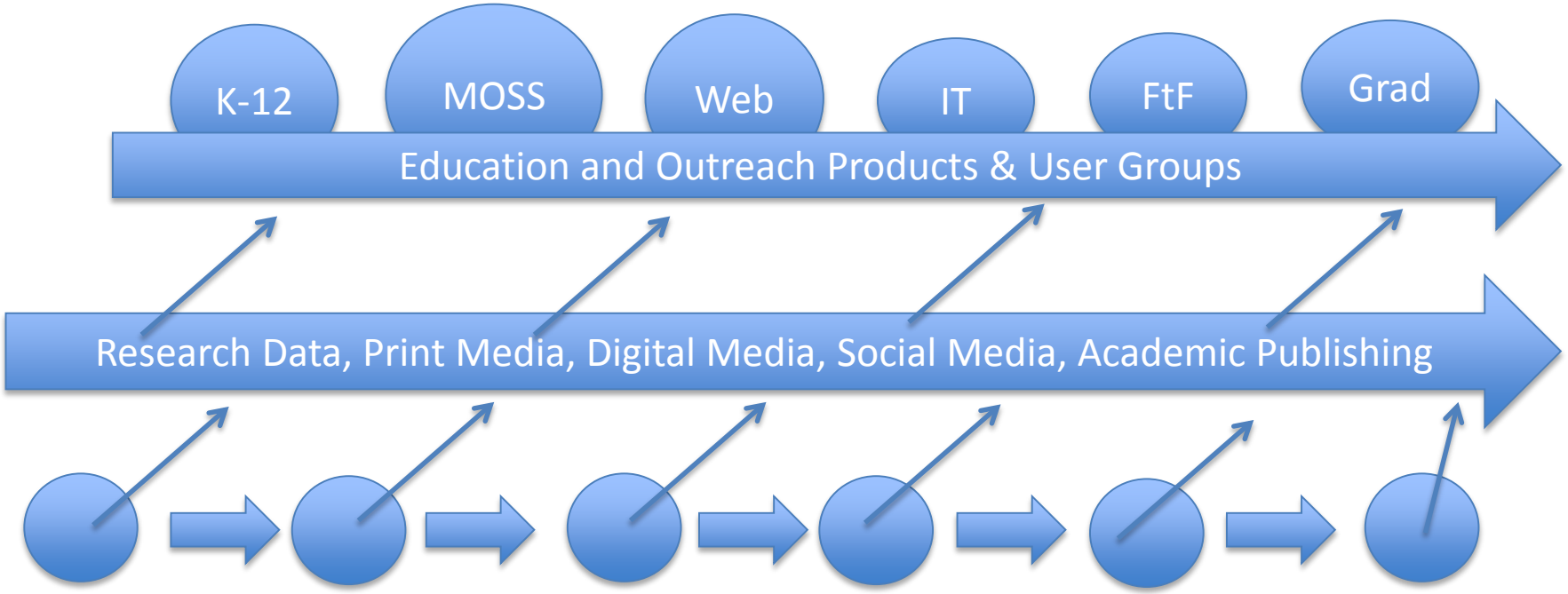

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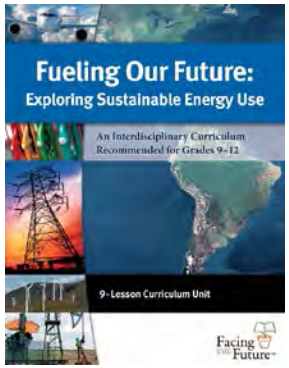
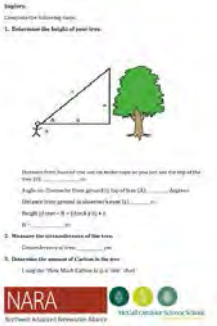
Impact

Energy Literacy
- Curriculum
- Media
- Assessment





- 2500 k-12 students/yr through direct instruction
- 60 teachers/yr through direct instruction
  - 2600 K-12 students through these teachers
- 16 graduate students/yr through year-long coursework
- 1000's of contacts through web-based resources
  - Blog
  - Matrix

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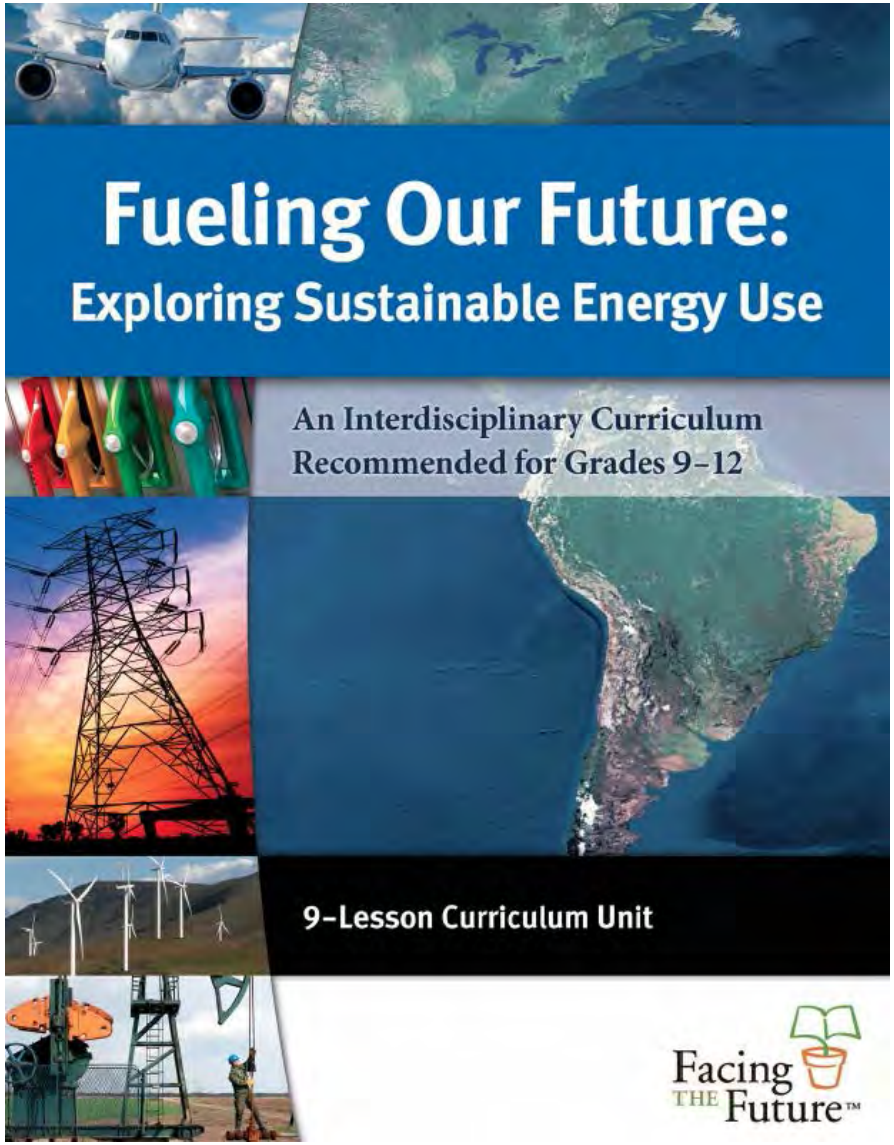
Cases: Facing the Future

Curriculum created by Facing the Future
2013 Launch
Online and print resource



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Cases: Facing the Future

Exploring energy literacy and biofuels - Activities parallel some NARA functions

Name Date Class

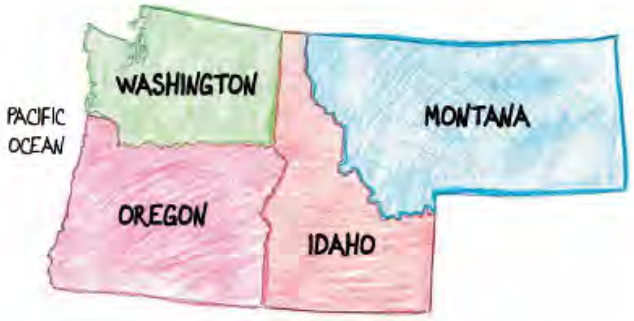
Scenario: Sustainable Flight in the Pacific Northwest

The federal government has mandated that an increasing amount of biofuel be mixed into jet fuel over the next few years in order to reduce the amount of crude oil used in the nation. The federal government has established regional councils to help identify the most sustainable biofuel feedstock(s) for different regions in the nation. You have been selected to be a part of the Pacific Northwest Regional Biofuel Council. This region includes Washington, Idaho, Montana, and Oregon. Over the next few days, you will:

- identify and understand the reasons for developing aviation biofuels,
- conduct research on different kinds of biofuels and consider their impacts on the environment,
- represent a specific stakeholder at a negotiation, identify other stakeholders' perspectives, and create a policy that identifies a sustainable fuel mix for the Pacific Northwest region,

so that you can answer the following question:

What are the most sustainable biofuels that can be produced in the Pacific Northwest for aviation?



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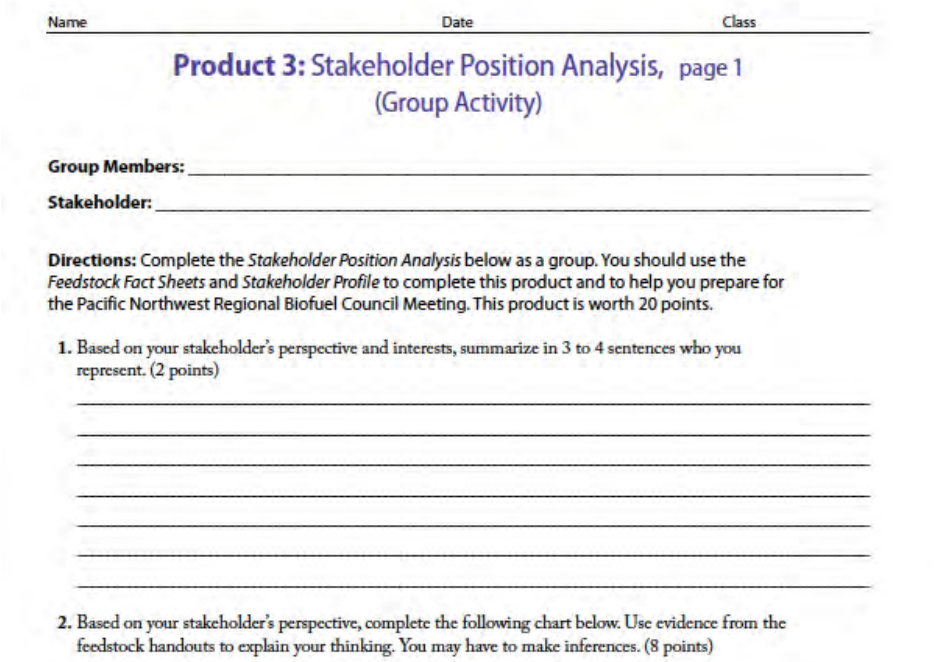
Cases: Facing the Future

Stakeholder activity



Name Date Class

Product 3: Stakeholder Position Analysis, page 1
(Group Activity)

Group Members: _____

Stakeholder: _____

Directions: Complete the *Stakeholder Position Analysis* below as a group. You should use the *Feedstock Fact Sheets* and *Stakeholder Profile* to complete this product and to help you prepare for the Pacific Northwest Regional Biofuel Council Meeting. This product is worth 20 points.

1. Based on your stakeholder's perspective and interests, summarize in 3 to 4 sentences who you represent. (2 points)

_____
_____
_____
_____
_____
_____
_____

2. Based on your stakeholder's perspective, complete the following chart below. Use evidence from the feedstock handouts to explain your thinking. You may have to make inferences. (8 points)

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Stakeholder activity

Name Date Class

Product 4: Stakeholder Meeting
(Group Activity)

At the stakeholder meeting, your stakeholder group will need to negotiate with other groups in order to create a policy recommendation for a sustainable biofuel mix in the Pacific Northwest. Along with the Stakeholder Position Analysis you complete in preparation for the stakeholder meeting, your group participation in the meeting will also be assessed based on the following rubric. All students in a group are expected to speak up equally.

Rubric for Negotiation

	4	3	2	1
Collaboration	• Negotiates in ways that are respectful • Effectively communicates to move the conversation forward • Effectively engages	• Tries to negotiate in ways that are respectful • Effectively communicates and sometimes moves the conversation forward	• Sometimes tries to negotiate in ways that are respectful • Attempts to communicate, but does not always move conversation forward	• Does not negotiate in ways that are respectful • Does not attempt to communicate or move conversation forward

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Supply chain

Name Date Class

Product 2: Suppy Chain Evaluation, page 1
(Individual Activity)

Directions: After you have participated in the Gallery Walk, reflect on what you have learned about biofuel supply chains by answering the following questions. Be sure your answers show critical thinking and evidence where necessary. Each question is worth 2 points.

1. Describe either a) the similarities and differences between the biofuels you learned about, or b) a pattern you observed among the different biofuel supply chains.

2. How did the suggestions provided by your classmates compare to your ideas about improving the sustainability of your supply chain?

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Use of NARA field data and media

5. Now use the flow chart to outline the supply chain for one specific biofuel, corn-based ethanol. Consider writing this on a

difference between biomass feedstocks and petroleum feedstocks is that the biomass feedstocks absorb carbon dioxide.)

The Supply Chain of a Fuel

Feedstock → Extraction → Transportation → Conversion → Distribution → Consumption

↓

Co-product

Option: Use one of the following videos to review the carbon cycle and the unique impact that fossil fuels have on the natural balance of this cycle.

- *The Hydrologic and Carbon Cycles: Always Recycle! – Crash Course Ecology#8*
  http://www.youtube.com/watch?v=2D7hZpIYICA
  This video provides a fun, fast-paced explanation of the carbon and hydrologic cycles. To skip ahead to the carbon cycle, press play 5 minutes into the video. The carbon cycle segment is 5 minutes long.

2. Explain that small groups will conduct research on the supply chain of a particular biofuel to assess its sustainability in the Pacific Northwest. They will then create *Product 1: The Life of a Fuel Poster.*
3. Refer students to *Product 1: The Life of a Fuel Poster* in their packet and discuss the guidelines for completing this product.
4. Divide the class into groups of 3-4 students and assign each group 1 of the 4 feedstocks listed below. Depending on your class size, you may have more than one group researching the same topic.

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Cases: Facing the Future

Credit to partners

Acknowledgements

Curriculum Development
Danica Hendrickson, MEd
Danielle Shaw, JD
Sheeba Jacob, MEd
Alicia Keefe, MEd
Laura Skelton, MS

Design and Layout
DECODE, Inc.

Copy Edit
Christie Heyer

Field Testing

Thank you to the following educators and their students for field testing this curriculum.

Erica Bergamini
Math and Science Teacher
The Northwest School
Washington

Denise Clemens
Environmental Science Teacher
Northwestern High School
South Dakota

Elise Cooksley
Social Studies Teacher
Two Rivers School
Washington

Sandra DeSimone
Environmental Science Teacher
Walter Reed Middle School
California

Tim Frykoda
Science Teacher
Strathclair Community School
Manitoba, Canada

Shannon Granger
Physical Science Teacher
Genesis Prep
Idaho

Ann Holstrom
Special Education Teacher
Chehalem Valley Middle School
Oregon

Lori Lawton
Environmental Awareness Teacher
Moscow Middle School
Idaho

Daniel Lieberman
Natural Resources Teacher
North Olympic Peninsula Skills Center
Washington

McCall Outdoor Science School (MOSS)
University of Idaho
Idaho

Carly Ross
Enrichment Teacher
Lockport School
Manitoba, Canada

Mary Smith
Exploratory Science Teacher
eStem Middle School
Louisiana

Holly Uber
Science Teacher
International School of Stavanger
Norway

Cynthia Varamo
Science Teacher
St. Mary's School
New Jersey

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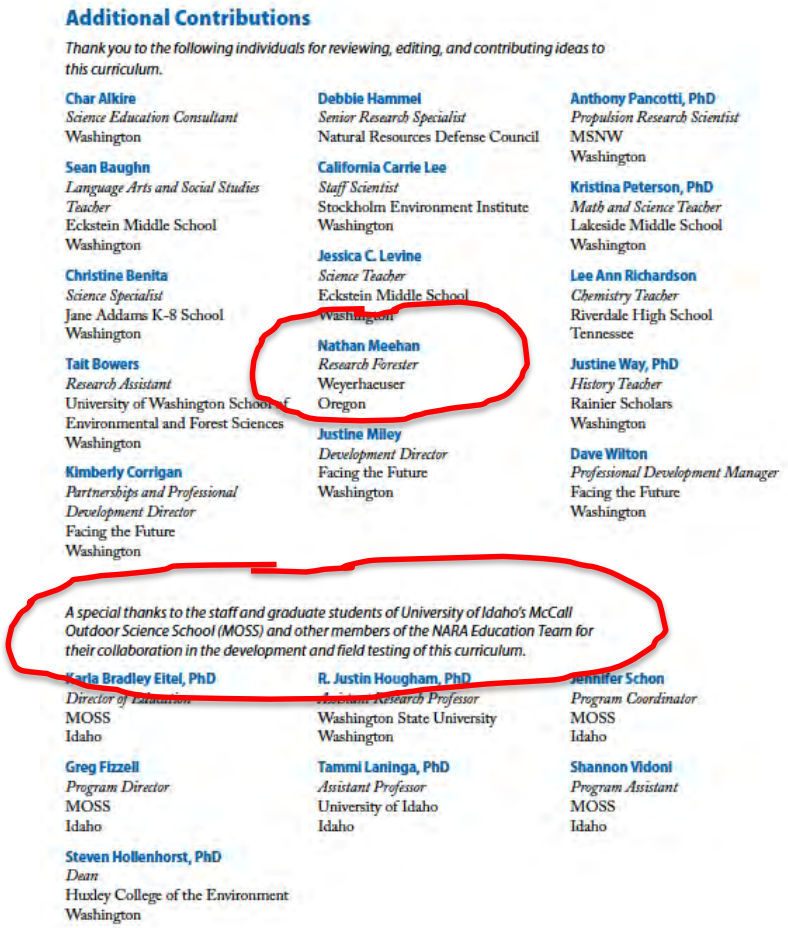
Credit to partners

- Indroneil Ganguly
- Tait Bowers
- Nathan Meehan
- MOSS Team



Additional Contributions

Thank you to the following individuals for reviewing, editing, and contributing ideas to this curriculum.

Char Alkire
Science Education Consultant
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Language Arts and Social Studies Teacher
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MSNW
Washington

Kristina Peterson, PhD
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Lakeside Middle School
Washington

Lee Ann Richardson
Chemistry Teacher
Riverdale High School
Tennessee

Justine Way, PhD
History Teacher
Rainier Scholars
Washington

Dave Wilton
Professional Development Manager
Facing the Future
Washington

A special thanks to the staff and graduate students of University of Idaho's McCall Outdoor Science School (MOSS) and other members of the NARA Education Team for their collaboration in the development and field testing of this curriculum.

Karla Bradley Eitel, PhD
Director of Education
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Washington

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University of Idaho
Idaho

Jennifer Schon
Program Coordinator
MOSS
Idaho

Shannon Vidoni
Program Assistant
MOSS
Idaho

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Field-based inquiries for
- graduate students
- teachers
- k-12 students

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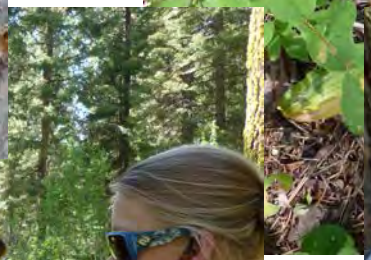
MOSS Graduates Field testing curriculum



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MOSS k-12 students in the field

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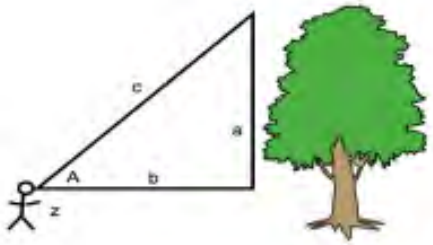
Explore:

Complete the following steps.

1. Determine the height of your tree.



Distance from base of tree out on meter tape so you can see the top of the tree (b): _____ m

Angle on clinometer from ground to top of tree (A):_____ degrees

Distance from ground to observer's eyes (z):_____ m

Height of tree = H = ((tanA x b) + z

H = _____m

2. Measure the circumference of the tree.

Circumference of tree:_____cm

3. Determine the amount of Carbon in the tree

Using the "How Much Carbon Is in a Tree" chart

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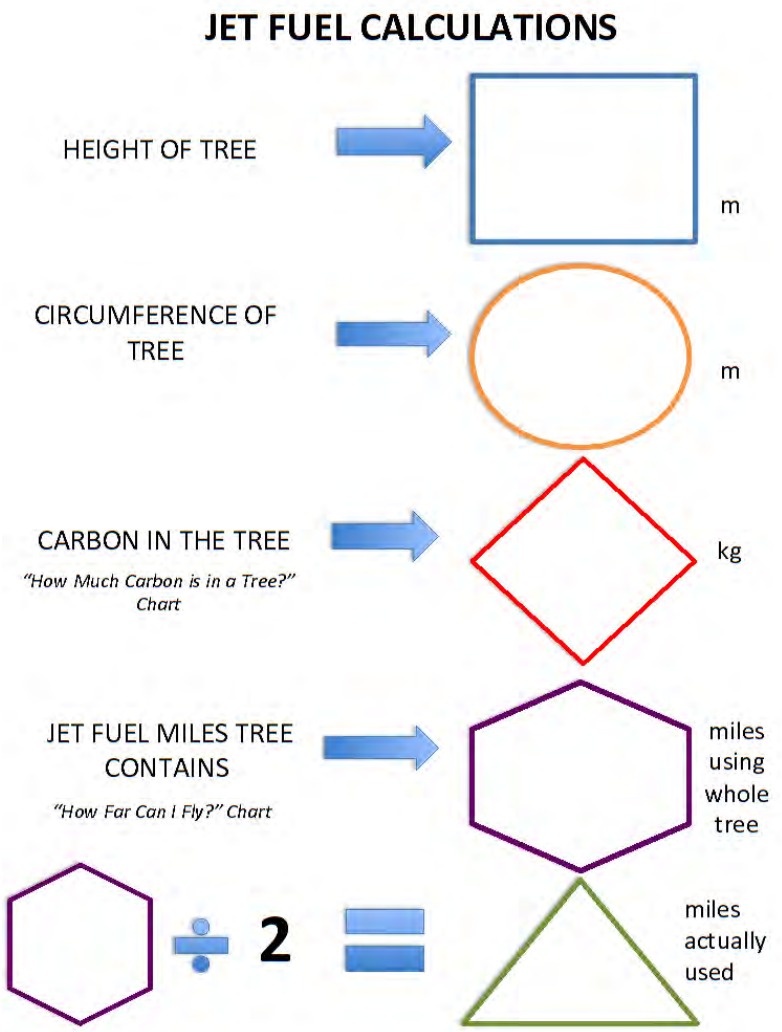
Testing curriculum development with graduates adds value and usability



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Cases: McCall Outdoor Science School

Curriculum published for national teacher audience

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Cases: McCall Outdoor Science School

Credit and acknowledgement to NARA:
Dwight Anderson (Catchlight)
MOSS Staff, Grads, and Faculty

Have students complete the following:

Your tree can fly _____ miles, it can produce_____ pieces of paper, it can sequester _____ kg of CO_2 per year, which is equal to about _____ days of a school bus driving. What's the best use of your tree?

Student's ability to answer the question will reflect their understanding of the assignment and the complexity of the question. There is no right answer in deciding to use slash from harvested trees for biofuel and lumber material or to leave them for carbon sequestering. The important concept is to understand that there needs to be a balance and that the answer is not an easy one.

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Anderson, Dwight. Catchlight Energy. (personal communication, June 7th, 2012).

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Project Learning Tree. Focus on Forests Activity 8-Climate Change and Forests (2010). American Forest Foundation. Retrieved from July 9th, 2012 from http://www.plt.org/focus-on-forests-activity-8---climate-change-and-forests

Math! How much CO2 is released by Aeroplane? (May 8, 2007). Environment, Math! Retrieved July 9th, 2012 from http://micpohling.wordpress.com/2007/05/08/math-how-much-co2-released-by-aeroplane/

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Cases: Imagine Tomorrow

Cases: Imagine Tomorrow

Teacher professional development model
- Support and workshops for teachers
- Direct support from NARA researchers
  - Natalie Martinkus
  - Indroneil Ganguly

MOSS
McCALL OUTDOOR SCIENCE SCHOOL

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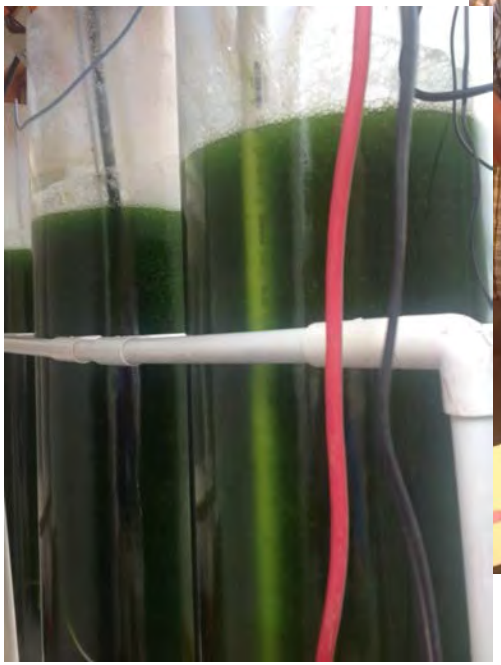
Cases: Imagine Tomorrow

Student projects from across the state brought to Pullman to compete



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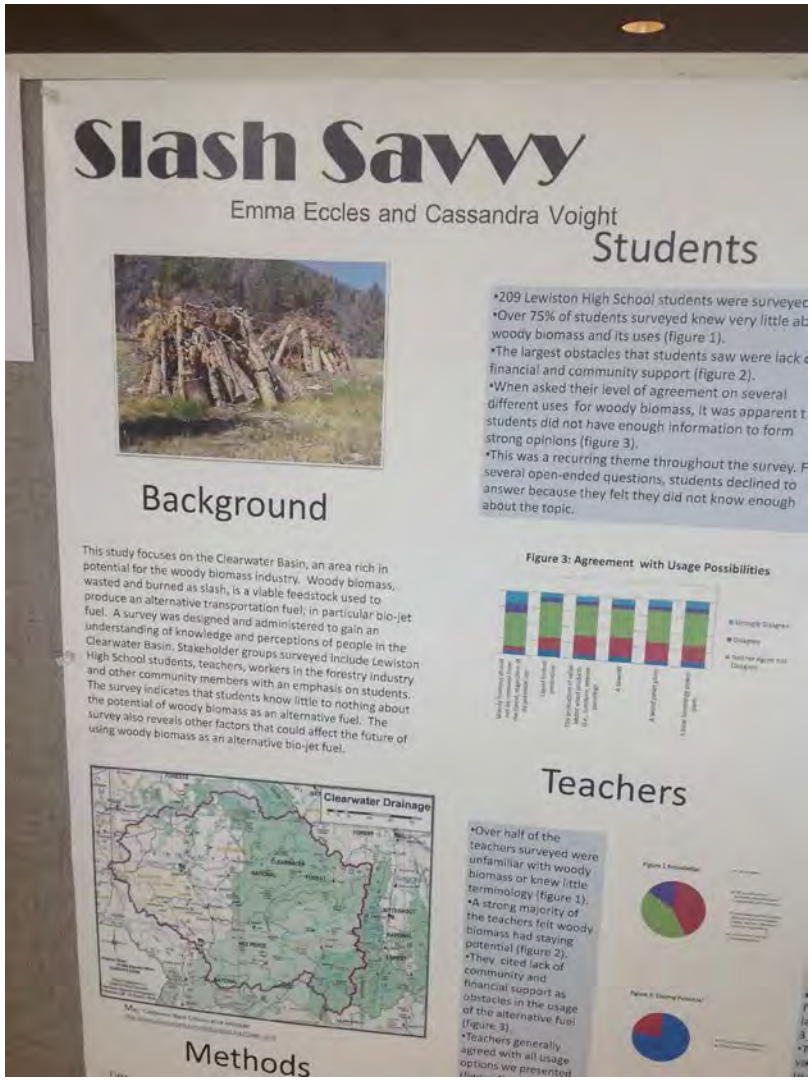
Cases: Imagine Tomorrow

Specific example of teacher and students from a NARA community.



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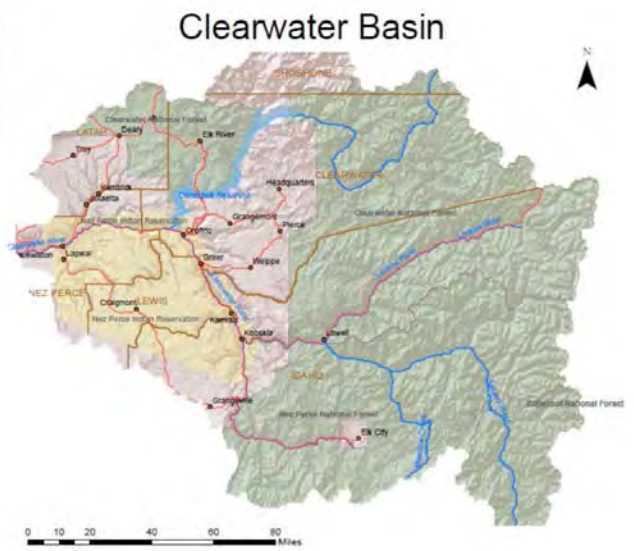
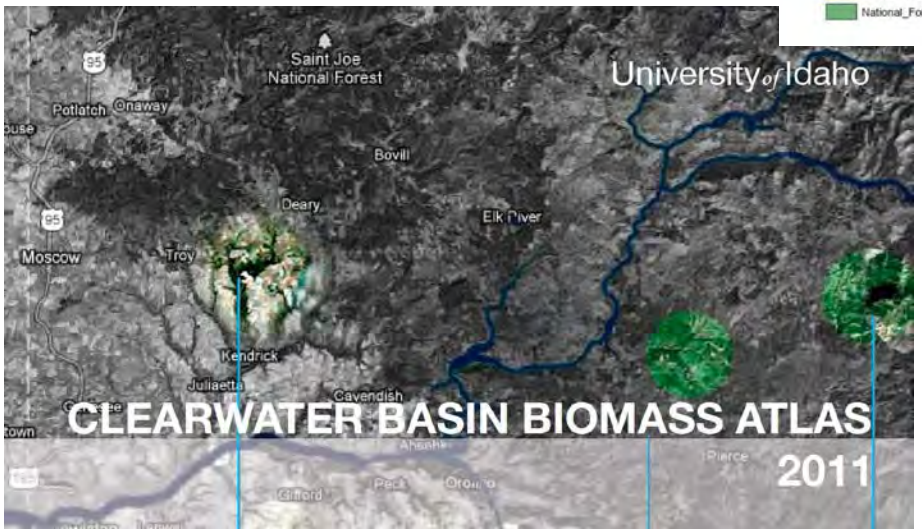
Cases: Imagine Tomorrow

Tammi Laninga
Jillian Moroney
MOSS Graduate Students
IDEX Students
Imagine Tomorrow Teachers

Figure 1: Clearwater Basin in the State of Idaho

Source: Jason Boal and Dan Callister with data obtained from Inside Idaho, http://cloud.insideidaho.org.





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Cases: Long Term Soil Productivity

LCA
Sustainability
and
Context

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Cases: Long Term Soil Productivity

Academic and research publishing

Forest Ecology and Management 305 (2013) 60–66

Contents lists available at SciVerse ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

Tree growth ten years after residual biomass removal, soil compaction, tillage, and competing vegetation control in a highly-productive Douglas-fir plantation

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ARTICLE INFO

Article history:
Received 12 February 2013
Received in revised form 16 May 2013
Accepted 17 May 2013

ABSTRACT

Forest residual biomass harvesting is a potential concern in regions where this primarily branch and needle material is removed to provide a source of renewable energy or where total-tree yarding takes place. Concern arises from the removal of nutrients present in residual biomass, as well as from heavy equipment trafficking used to collect the material. The Fall River Long-term Soil Productivity (LTSP) Trial in

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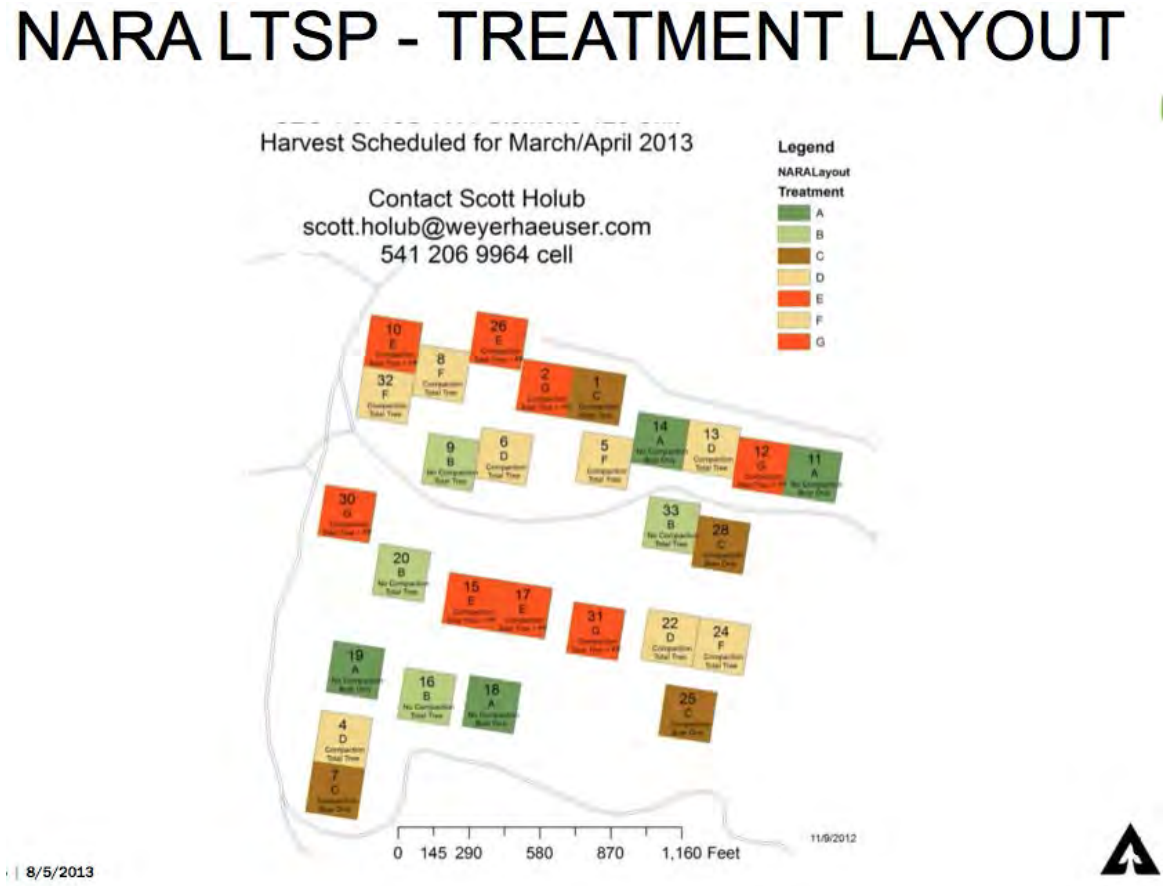
Cases: Long Term Soil Productivity

Methodology that informs inquiry



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Cases: Long Term Soil Productivity

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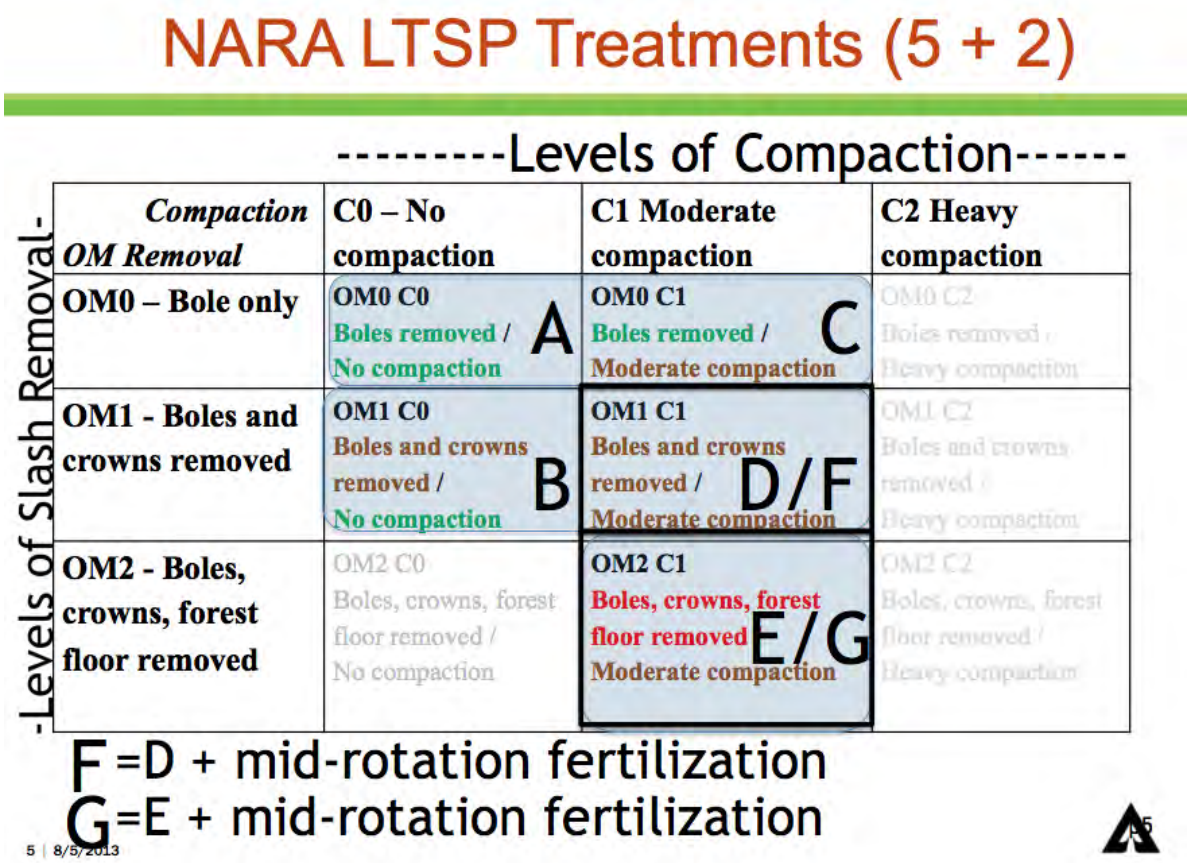

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Scott Holub
Nathan Meehan
Weyerhaeuser

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Cases: Outreach Efforts

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Greenway Recycling
Eini Lowell
BioPacific
Vik Yadama
Karl Englund
Natalie Martinkus
Scott Leavengood
Peter Grey
Gifford Pinchot Task Force

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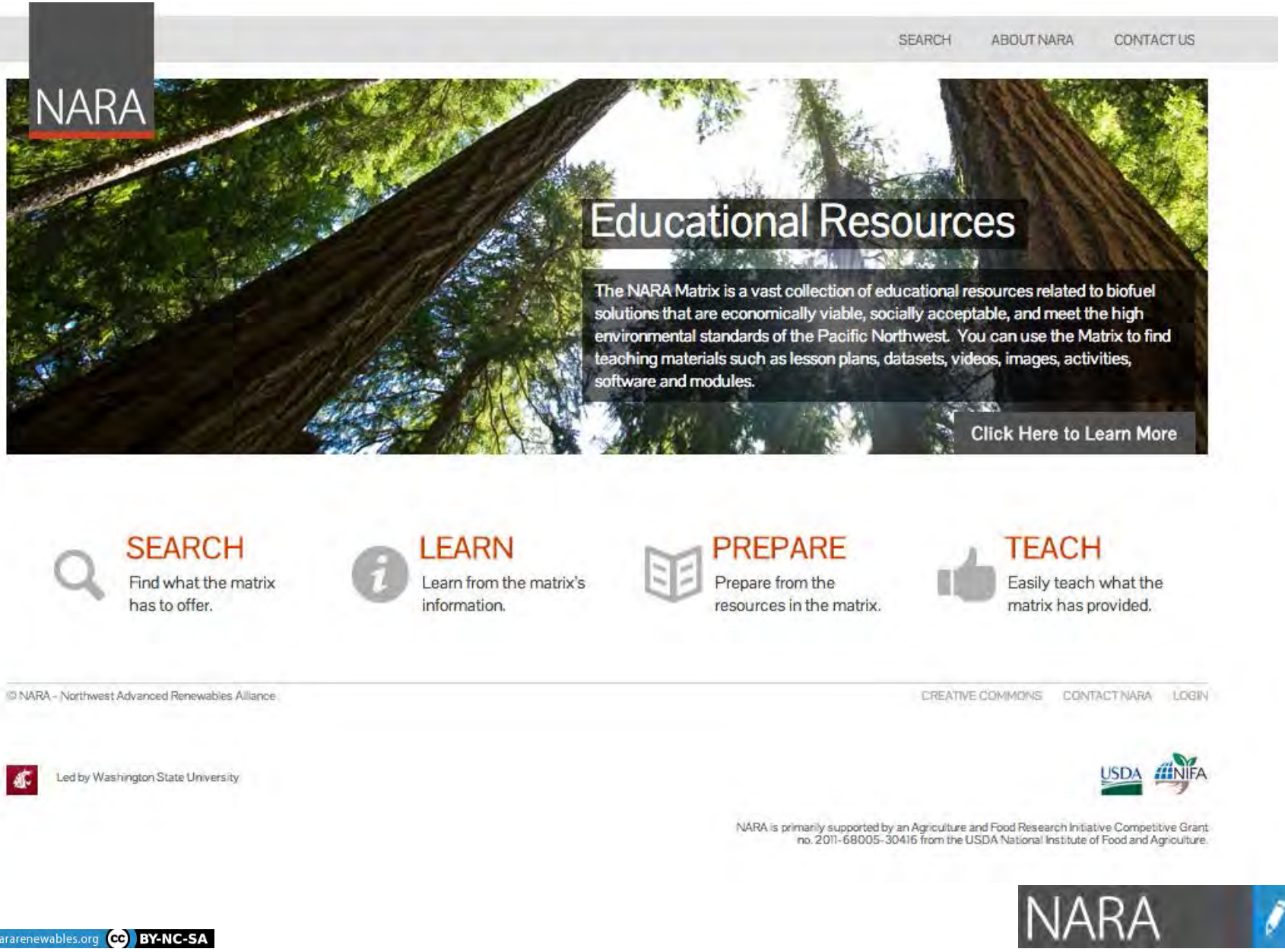
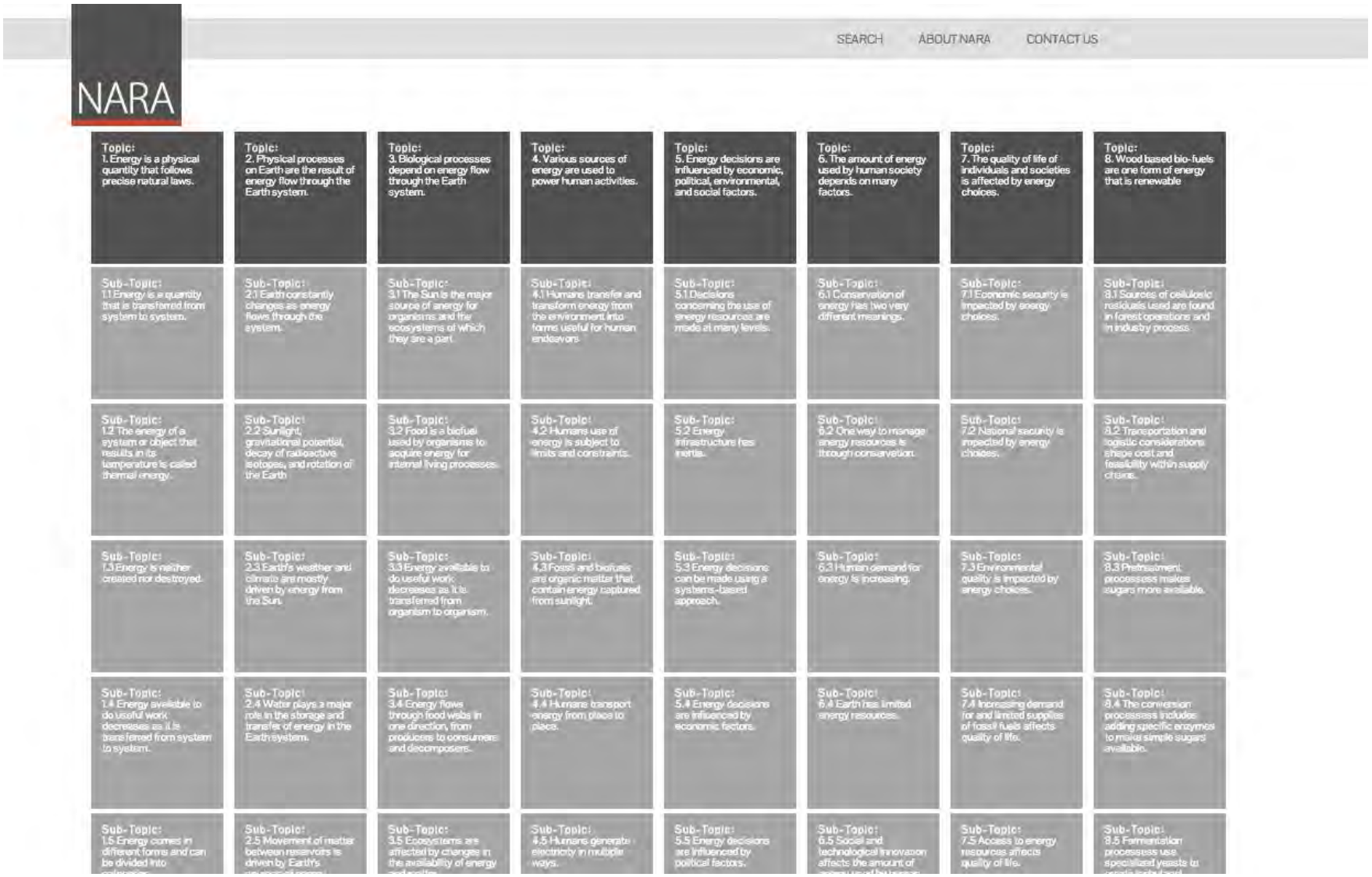
Cases: Websites and Blogs



NARA

Cases: Websites and Blogs



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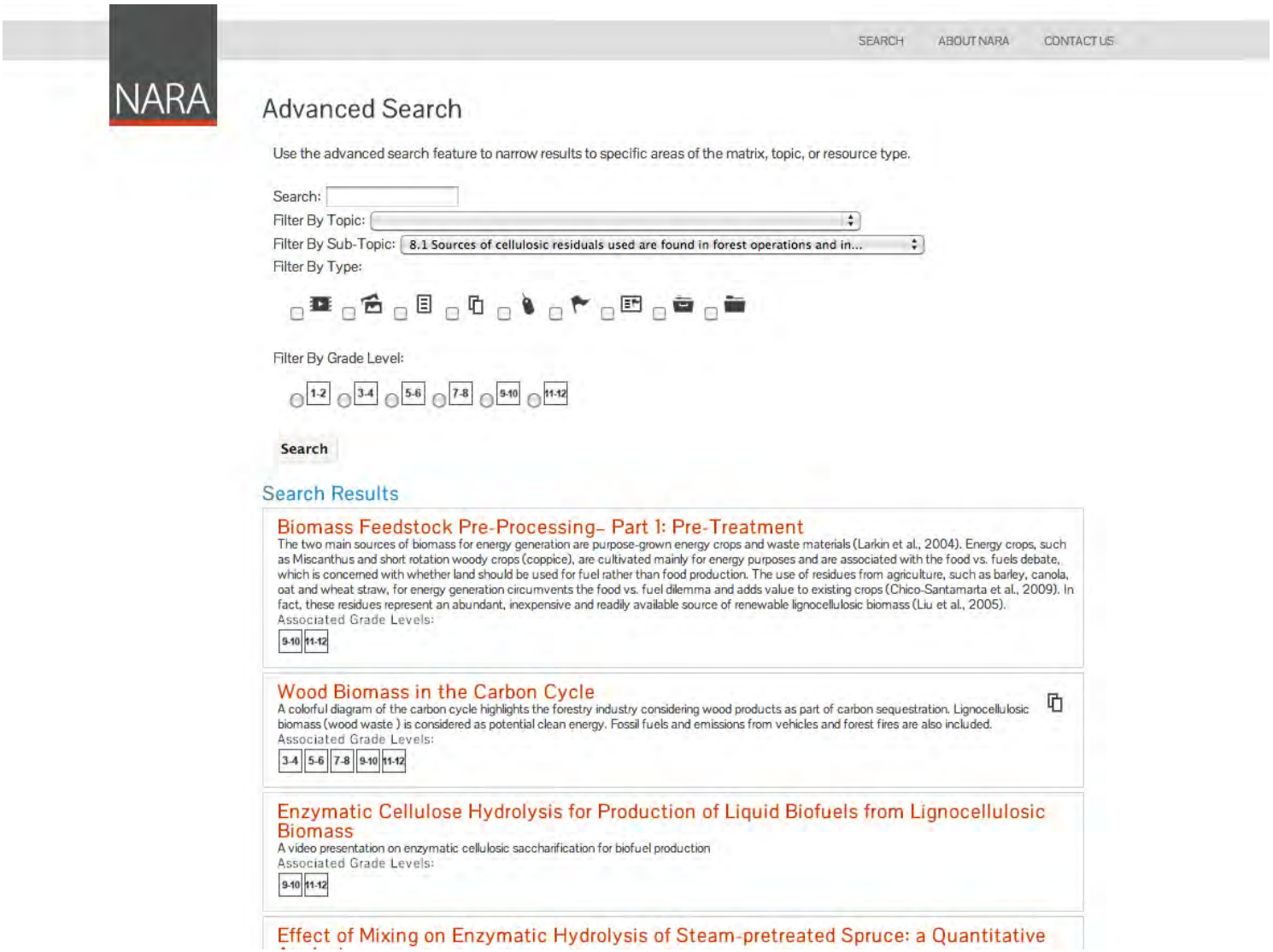
Cases: Websites and Blogs



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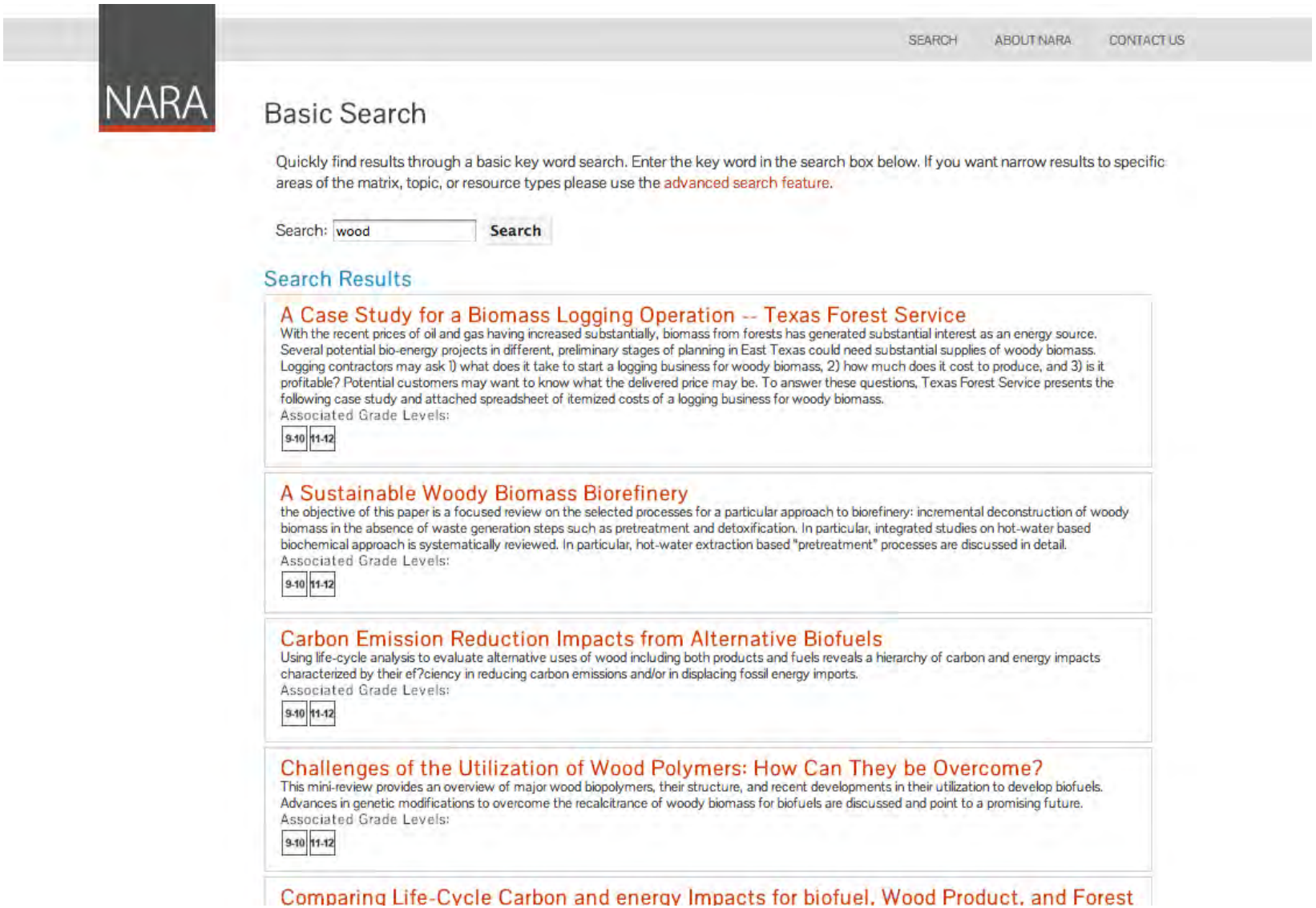
Cases: Websites and Blogs



NARA

Cases: Websites and Blogs

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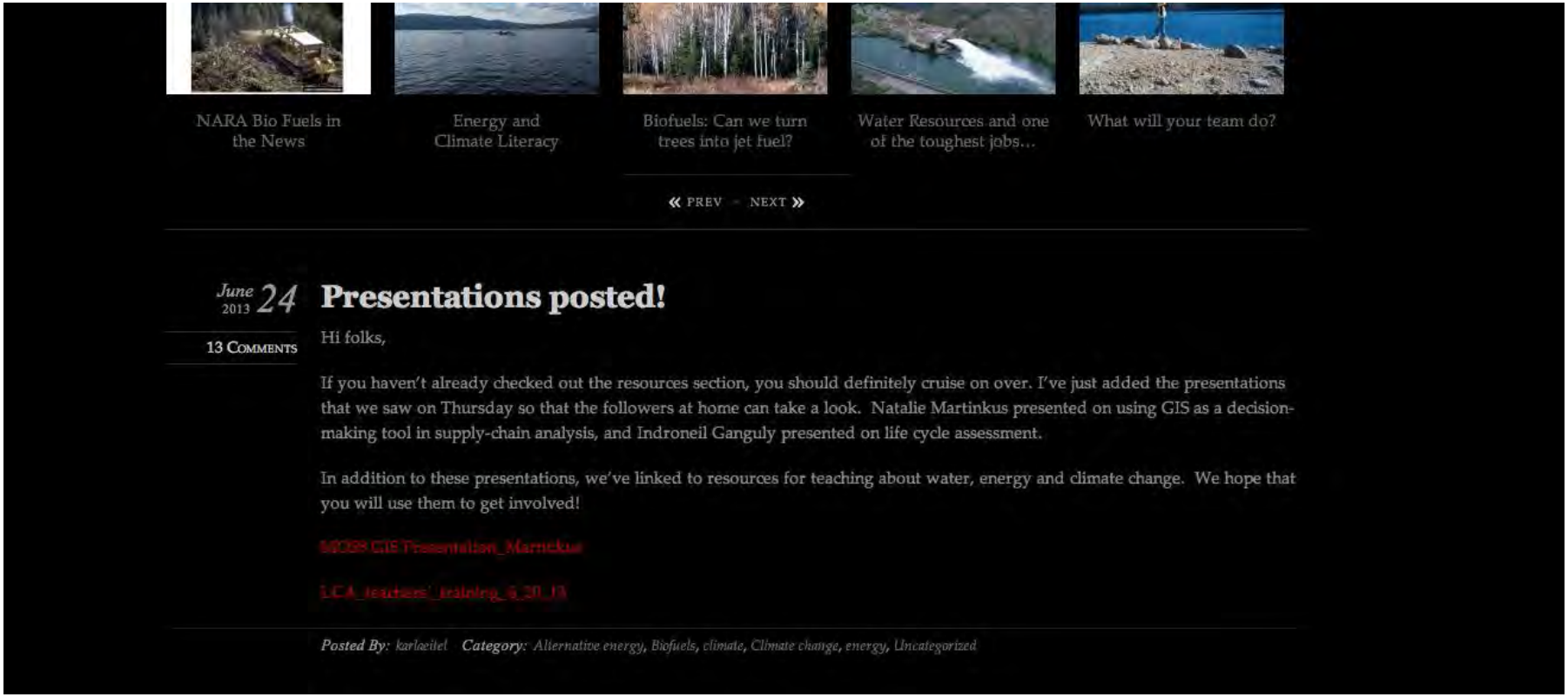
Cases: Websites and Blogs

Real time connections to stakeholders and educators



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Cases: Websites and Blogs

Real time connections to stakeholders and educators

NARA
Northwest Advanced Renewables Alliance

About News & Features Teams Members Blog

NARA BLOG

On The Road: NARA Researchers and Team Members Visit with Stakeholders in Southwest Washington and Northwest Oregon

July 9-11 NARA researchers visited several sites in the greater Portland area to learn more about resources and relationships that will shape our understanding of biomass issues. This trip included visits with wood recyclers, biofuel processors, environmental organizations and a log yard.

Teevin Brothers Log Yard was our first stop in Washington outside of Longview. At this facility, logs are collected from trucks, sorted, stored and shipped to various markets.

http://www.teevinbros.com/

RECENT POSTS

Co-product development: lignin-based molecules for commercial epoxies
September 4, 2013
Forest Inventory and Utilization Data
September 4, 2013
Improving simple sugar yields from wood residuals September 4, 2013
John Sessions to receive national award from the Society of American Foresters
August 28, 2013
Energy Literacy: A new team begins the year at the McCall Outdoor Science School August 20, 2013

CATEGORIES

Blogs
Co-products
Creating Biojet Fuel
Energy Literacy
Supply Chain Coalitions
Sustainability and Job Creation

ARCHIVES

September 2013 (3)
August 2013 (2)

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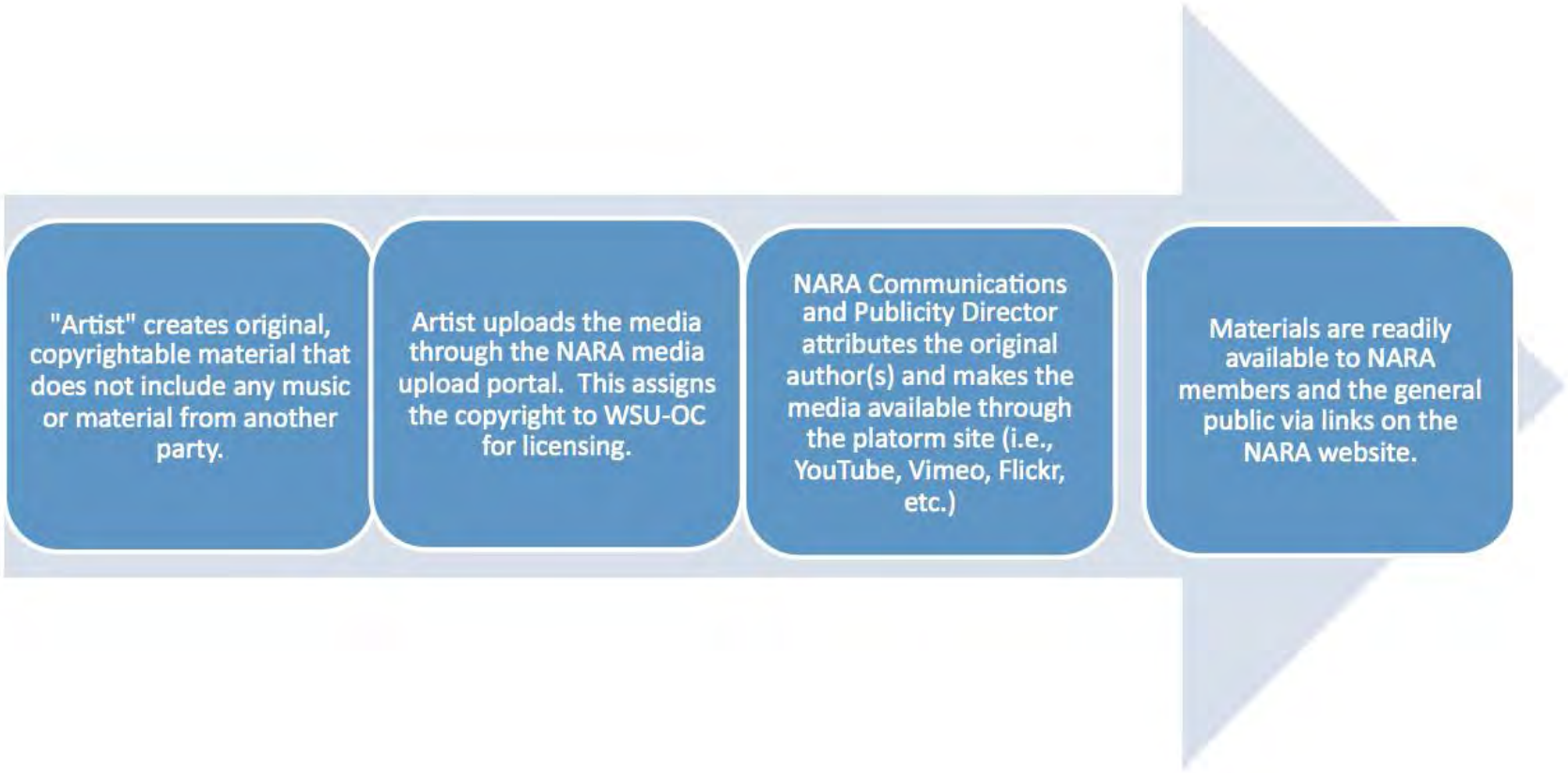
Copyright

Media artifacts and creative work



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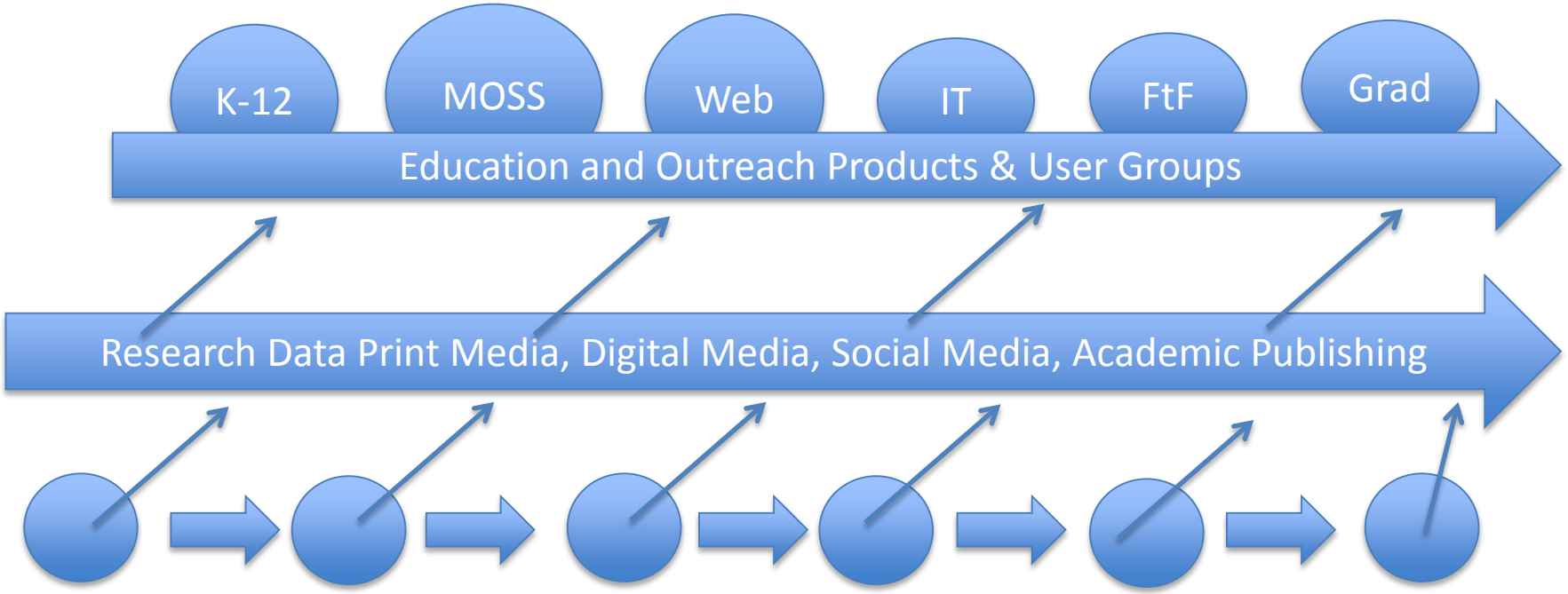
Flow for Education and Outreach of NARA research



-Life Cycle Analysis
-Community Partnerships
-Capitals Framework

Feed Stock

Transportation

Pretreatment

Conversion

Biofuel and co-products

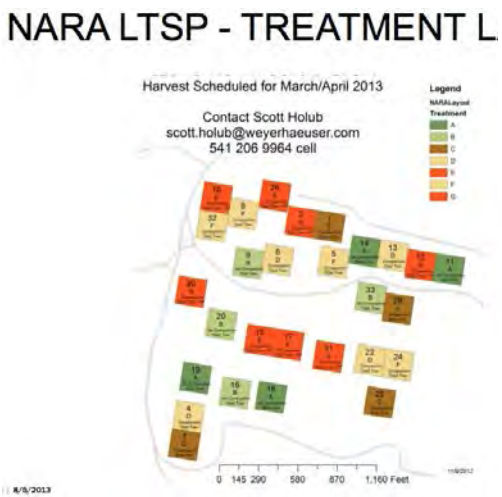
NARA

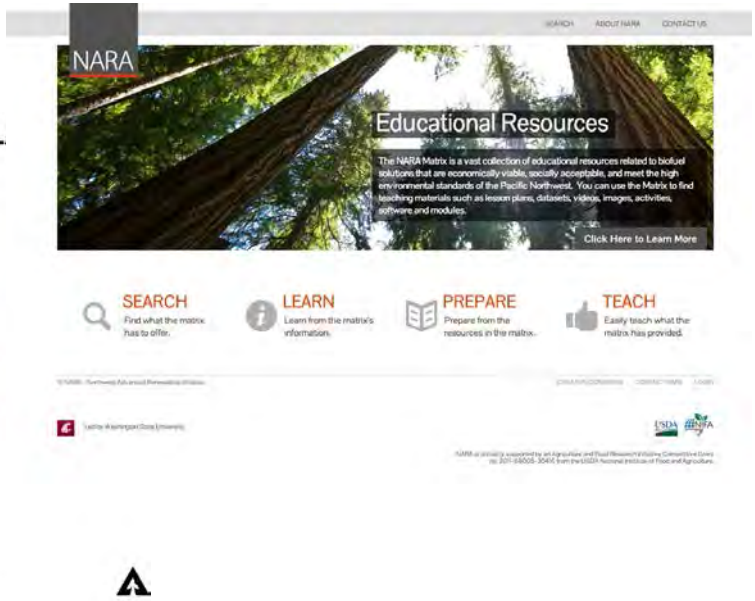
Moving Forward

Ways to contribute to the Energy Literacy supply chain:

- Data
- Graphics
- Guest talk
- Editorial
- Student and teacher support

Design objective: Timely, inspiring, accurate and complete





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Integrating Research and Education: Education at the Speed of Research

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NARA Education and Outreach
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