

## Biomass Adventure Race

**Overview:** This adventure race lesson covers the four key stages of the biomass supply chain: production, pre-processing, conversion, and supplying to consumers.

**Keywords:** Supply chain, biomass, pre-processing, conversion, biofuel

**Age / Grade Range:** 9<sup>th</sup>-12<sup>th</sup>

**Background:** The development and use of biofuels as an alternative to petroleum can be one strategy to help reduce greenhouse gas emissions. Biofuels can be produced renewably and can also help attain self-sufficiency in energy production. The term “biomass” refers to biological material that is living or was alive, and often is from a plant or plant derived. The biomass supply chain refers to the flow of biomass material from harvest points to its eventual end use. This process of how it gets from start to finish, includes four key stages; production, pre-processing, conversion, and supplying to consumers.

Students will benefit from having previous lessons on the biomass supply chain, especially pre-processing and conversion as these stages are more in-depth. However, they will learn about each stage throughout the adventure race so it isn't imperative that they have previous knowledge.

**Next Generation  
Science Standards &  
Common Core:**

HS-PS1.A Structure and Properties of Matter  
 HS-PS1-B Chemical Reactions  
 HS-PS4: PS3.D Energy in Chemical Processes  
 HS-LS2.C Ecosystem Dynamics, Functioning, and Resilience  
 HS-LS2: ETS1.B Developing Possible Solutions  
 HS-LS4. D Biodiversity and Humans  
 HS-ESS2.D Weather and Climate  
 HS-ESS3.A Natural Resources  
 HS-ESS3.C Human Impacts on Earth Systems  
 HS-ESS3.D Global Climate Change  
 HS-ESS3. ETS1.B Developing Possible Solutions

**Goals:**

- What are the key stages of the biomass supply chain?
- How are geography and transportation connected?
- What did you learn about yourself and your teammates?

**Objectives:**

- Review and understand the key stages of the biomass supply chain
- Explore the challenges and complexities that exist in transporting, storing, and handling biomass
- Discover how geographical and human characteristics of an area influence movement of biomass throughout the chain
- Experience the ecosystem of Ponderosa State Park by canoeing and trekking
- Recognize the challenges in different stages of the supply chain
- Develop the students' sense of place as they navigate with a map and compass and learn the various terrain, abiotic and biotic features of the ecosystem

**Materials:**

- Canoes
- Paddles
- Life Jackets
- Ponderosa State Park Maps
- Compasses
- Check Point Markers
- Flags
- Index Cards (aka Task Cards)
- Bags of Potatoes
- Cheese Graters
- Storage Containers
- Water
- Rock Hammers
- Supply Chain Diagram Visuals
- Adventure Race Video
- Cameras
- Small Dry Bags
- Cell Phones
- First Aid Kits
- Plant Press Boards
- Rubber Bands
- Notecards

**Set up:**

To set the course (all the check points, CPs), pick out locations close to landforms and features that stand out, like points along the shoreline, streams, marshes, or open terrain. You will need to keep in mind when groups will be canoeing, so that in the end the canoes all end up back in the same place. Use flags to mark CPs, also known as controls. Teams will prove they have been to a check point, by having photo documentation showing tasks performed and recording code words that the course setter has put at each CP.

Check to see there are enough canoes (which represent travel by rail car) and

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you have a plan for the water/canoe safety talk.

Each team will need a plant press board with a note card attached by a rubber band. This is where they will record their CP code words. On the note card write on separate lines: depot, pre-processing, conversion, and consumption.

Set multiple CPs for depot and consumption sites, single CPs for pre-processing and conversion sites. [Note if there is more time there can also be multiple CPs for pretreatment and conversion. Since pre-processing and conversion require more specific design these sites will likely be more consolidated in the real world.] CPs can be flags or some other material that is sticking up or attached to a hanging branch.

Each CP will have a task card. Task cards are designed so groups will have to discuss what their options are and decide where and how to transport, handle, and store biomass. Students will come across challenges at different scales and need to decide what to do within their timeframe. They will recognize advantages and disadvantages and have to make choices about the types of transportation and sites they choose to visit. You also add more to the task cards, for example if you want to assess their understanding of two concepts you can say “Draw or describe the difference between pre-processing and conversion.”

Teams will start out looking for potatoes and twigs or wild onions of various sizes (representing diversity of feedstocks). Course setter will lay 4 potatoes on the ground in several designated areas (one area per team that is racing). Course setter can either write a clue for teams to find their biomass, or place a CP on the map to mark it. Instruct teams to pick out different sizes of sticks.

Check point cards will have different labor and/or decision making tasks and problems on them depending on the site.

**Depot** sites are gathering points. Provide sacks at these CPs which illustrates compiling the biomass for transport to the next site. There will be several task cards. They will say different things to illustrate complexities that not all parts of the supply chain will run smoothly, or it can go better than expected. Each number here refers to a different depot site. 1. Place potatoes and biomass materials into sacks to transport. 2. Place potatoes and biomass materials into sacks to transport. There has been a delay in transportation. Wait 3 minutes before proceeding. 3. Place potatoes and biomass materials into sacks to transport. Your truck driver is on time, record a 1 minute time bonus, which can be used if you finish the race on time. All these cards will also specify, “You must transport this load to a railcar and take the railcar to get to your next point.”

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Code word: Gathering point

**Pre-processing** is where the material is processed so it will be easier to break down. Make task card to say “take the cheese grater and separate the skin from the potatoes.” If there are enough cheese graters, have each team carry one, otherwise place them at pre-processing CP.

Code word: Doing the work! Lignocellulosic degradation

**Conversion** is where fermentation, distillation, hydrolysis and refinement happens. Provide vinegar and gallon of water at this CP. Task card will have multiple steps. It will say “Break potatoes into smaller pieces, place in soaking containers and add water and vinegar to represent fermentation and distillation. Carry soaking biomass to a secondary conversion site. You must not spill any material, if you do record a 1 point deduction for this CP” (Place a flag around 100 feet away with one more task card.) This represents the refinery. Task card will say “take the chunks out of the liquid (byproducts), and decide how to transport the refined biofuel onward. You must transport by railcar along the way to your consumption sites.”

(Place consumption CPs near your finish area, where you want all the canoes to come back)

Code word: Multiple steps.

**Consumption** is where the final product is bought and used by consumers. Place a bucket here to represent a holding tank. Task cards will include (again each number here represents a different CP): 1. Pour your biofuel into holding tank. Your fuel spilled and you need to clean it up, record a 2 minute loss. 2. Pour your biofuel into holding tank. Prices have gone down, record a 1 minute loss.

The team that makes it to all the CPs and to the finish line (set this up where you want it to be), with the best time (take into account gains and losses from their tasks) wins!

You will need this link: <http://www.amongthewild.com/justin-bakken-national-adventure-racing-champion/> to show the Wedali Adventure Race video to give students an idea of a real adventure race.

You will need to divide your students into teams of 2-4 people per team.

2-5 hours. You can make the race longer or shorter depending on how you set the course

### Classroom Time:

### Introduction (Engage):

Review and discuss the biomass supply chain. Utilize supply chain diagram visuals (see link in additional resources). Briefly explain the rules of the race and show the Wedali Adventure Race video.

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Explain that teams will go out to gather a potatoes and twigs, aka "biomass" at a designated location given to them on their map. The map will also have check points marked out showing where the depots, pre-processing, conversion and consumption sites are. They will have to make various decisions throughout the race and most likely won't see the other teams at all the same CPs because depending on route and site selection there are diverse ways to go through the race. For example, there are several depot and consumption sites and any of them can be selected, but not all of them will be needed.

The rules include that teammates must stay within 100 feet of each other at all times-this is an integrity rule, as we have no way of enforcing it, unless we see them out on the course. There is a cut-off time, if a team doesn't get back before this time they will be penalized by point withdrawal (point out economics of biomass supply chain).

Show an example of a CP task card and explain that they will have to perform certain tasks at certain sites in order to get points for being there. Pictures will be the proof that the task was performed. Bonus points can be given for best racing pictures to encourage them with digital media development that can be used for their final project.

Break into two teams and do a name game/team builder, to learn name of your teammates and come up with a team name. Have them write team name on their CP recording card.

Assign roles - Note that roles can be switched and shared throughout the race.

1. Navigator- has the map and compass, helps group navigate to check points

2. Check Point tracker- keeps record of all the CP code words

3. Point person- a teammate who has the overall picture in mind, sees details but also is aware of any rising challenges that need to be addressed such as interpersonal, environmental, equipment, personal, or other challenges that may present themselves. Will carry a cell phone if needed for emergency.

4. Time tracker- keeps track of time and ensure group gets across the finish line before 13:00 (arbitrary, assign designated finish time).

5. First-aid expert- carries the first aid kit and addresses any injuries, hot spots, or health concerns

6. Photographer- carries the camera and records fun and CP task photos

**Activity  
(Explore)/Explain:**

Everyone on the team needs to be aware of food and water intake.

Explain that each team will have to make decisions along the way, for example what to do with byproducts, and this is an adventure race, expect the unexpected! [Deduct 1 minute losses if they don't bring back the byproducts- potato peels, because its not following leave no trace principles- but don't tell them this, let them problem solve]

Go to the canoe shed and review canoe safety.

Explain map and compass skills. Point out key features on the map, in case groups lose orientation. Discuss how to identify landforms such as the shoreline, elevation changes, marshes, streams, and buildings. Point out safety/evacuation points in case of emergency. Each group will have facilitator phone number as well.

Transportation by foot represents using a truck to haul biomass and transportation by canoe represents railcar. Bigger loads are associated with railcar and will need to be transported by canoe, otherwise they will cost more to transport. CPs will specify when canoe is needed.

Any questions? Check that students have appropriate gear- clothes, shoes, snacks, water, camera, maps, and compass.

Game Time

What resources do you have and where do they need to be transported?  
Where are your sites and what is the best way to get there?

Remind students that there are multiple sites for depots and consumption which relates to real-world supply chain.

When teams finish the race, have everyone gather together to discuss the following questions:

- What happened to the biomass as you transported it?
- What happened to your team as you progressed?
- What were the challenges you encountered during different stages of the supply chain?
- What were some infrastructure complexities?
- What interpersonal complexities did you encounter?
- When did you utilize railroad compared to truck? How might that be similar or different to the real world supply chain?
- What did you find most difficult?

**Elaboration:**

Draw connections between difficulty of certain processes, difficulties in communication as teams fatigue similar to difficulties encountered between people along the supply chain, challenges of handling the biomass during transport.

Have groups present their pictures to each other on the Smart board and highlight the key processes and challenges, as well as the most exciting parts of the race.

**Evaluation:**

Facilitate this process by asking questions to check understanding and clarify key points.

**Additional resources:**

**Biomass Source Visuals:**

<http://www.wgbn.wisc.edu/producers/biomass-sources>

**Alternative Fuels Data Center:**

<http://www.afdc.energy.gov/locator/stations/>

**Adventure Racing Website:**

<http://www.gobushwhack.com/>