Value of the Slash of a Tree

Overview: In this lesson students will look at forest ecosystems and determine the estimated slash of the tress. Other forest ecosystem discussions can be implemented as well such as fire ecology.

Keywords: Biomass, biofuel, slash

Age / Grade Range: 8th-12th

Background: Biofuel is defined as "liquid or gaseous fuels produced from biomass" by the Department of Energy ("Energy Basics: Biofuels," 2011). Biofuels may offer a sustainable solution to domestic energy independence while reducing greenhouse gas (GHG) and fossil carbon emissions (Hoekman, 2009a). Two major types of biofuels include biodiesel and ethanol (Chhetri et al., 2008; Lippke et al., 2012a; Simasatitkul et al., 2012) which can be produced in a variety of different ways by fermenting and processing renewable agricultural, woody, and urban waste products (Hoekman, 2009b; Lippke et al., 2012b; Smith & Searchinger, 2012; Somerville et al., 2010a). Current research is being conducted to increase the efficiency of biofuel production from lignocellulosic feedstocks and to evaluate the feasibility of using different types of biofuels in the transportation industry.

Next Generation Science Standards & Common Core:
MS-LS2.C Ecosystem Dynamics, Functioning, and Resilience
HS-LS2.C Ecosystem Dynamics, Functioning, and Resilience
MS-ESS3.A Natural Resources
HS-ESS3.A Natural Resources
MS-ETS1.B Developing Possible Solutions
HS-ETS1.B Developing Possible Solutions

Goals:

- Students will get a sense of place by investigating and comparing two local forest types, and by familiarizing themselves with several local tree species.
- Students will speculate on the problem of and opportunity resulting from logging waste.
- Students will estimate the mass of potential slash present per acre of each forest type.
- Students will address the different ecological factors that can be affected by forest management strategies.

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Objectives:

1. Students will understand that a large quantity of wood 'waste' is produced in the logging process, and that the amount of 'waste' produced differs between different forest types and structures.
2. Students will be able to identify several tree species in the areas they are sampling.
3. Students will understand that management practices greatly impact the ecology of a forest.
4.

Materials:

- Flags (4 per group)
- Meter tape (1 per group)
- DBH tape (1 per group)
- Calculator (1 per group)
- First aid kit
- Wristwatch (1 per group)
- IPad
- Directions handout for activity (1 per group)
- Forest Service slash estimator handout (1 per group)
- DBH and species table in which to record data (1 per group)
- Writing utensils and paper or notebooks
- Treefinder booklets (1 per group)
- Compass (1 per group)

Set up:

Determine an area in which to conduct the lesson. Ideally, the area would be in close proximity to two different looking forests (e.g., managed vs. unmanaged stands, ponderosa pine vs. grand fir dominated stands, etc.).

Classroom Time:

1.5 hours

Introduction (Engage):

Problem: *What should we do with leftover slash from logging?*

In terms of timber and industries involving wood, what is "waste" and where does it come from? (5 minutes)

- Clearing for fire management
- Waste from paper/lumber manufacturing
- Crop trees
- Slash (previously unmerchantable branches and crown tips) from other forest management activities
- Construction and demolition

How do forests differ, and how can these differences affect a forest's suitability for responsible biomass harvest? (5 minutes)

- Species composition
- Structural differences (e.g., tree size, age, density)
- Topographical differences (e.g., slope, aspect, elevation, etc.)

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How can we measure some of these differences? (1 minute)

- Random sampling
- Forest inventories
- Remote sensing

Activity (Explore):

1. Divide the group into smaller groups. Groups of four would be ideal.
2. Hand out materials, give directions, and send all of the groups to sample area 1 (e.g., either the managed forest or the unmanaged forest). The directions handout will be given to the groups as a reminder of the steps to be followed (provided in Appendix A). Frontload to each group that they will eventually be presenting their results to the rest of the group.
3. Have each group randomly determine a point at which to begin their sample plot. To do this, wander a ways into the plot. Then, to determine an azimuth, look at the watch and prepare to walk in the direction that the second hand points toward at that given moment. Encourage groups to figure out a technique that they could use to randomly generate a value for the number of paces to walk in that direction (e.g., take the tallest person and ask them their birthday, then take the same number of paces as the day they were born). Mark the point with a flag.
4. From that point, have groups measure 6.63 meters north, and place another flag. From there, measure 6.63 meters west and place a flag, then 6.63 meters south and place a flag. The resulting flags will constitute the corners of a square sample plot that is 1/10 of an acre in surface area.
5. For each tree in the sample plot, groups will measure diameter at breast height (DBH) using the DBH tape, and determine species using the tree finder. For trees that lie partially in the plot and partially out (the borderline of the plot transects the bole of a tree) count every other tree. Record DBH and species of each tree in the data table provided (see Appendix B). Encourage the rotation of jobs (i.e., species identifier, DBH measurer, recorder of data, and recorder of which trees to include and which were already sampled) amongst group members.
6. Calculate the *estimated slash per tree* by referring to the FS Slash Weight Table (appendix C), and record on data table.
7. Estimate and record the *total slash per sample plot* by taking the sum of the *estimated slash per tree* values.
8. Estimate and record the *total slash per acre* by multiplying the *total slash per sample plot* by 10.
9. Move the groups to sample area 2 and repeat.

Explanation/ Elaborate

Discussion of biomass removal. Elaborate and expand on ideas generated by students in presentations:

A. What ecosystem services do trees provide?

1. Define ‘ecosystem services’
2. Oxygen, wildlife habitat, shade, inherent value, water

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storage and use, water purification, nutrient cycling, erosion control, medicinal uses, CO2 sequestration, etc.

B. Impacts of biomass removal on ecosystems

1. Nutrient loss: how much nutrient loss is not harmful; at what point is it harmful? How do you define what is harmful and not harmful? How does this vary by management perspective and priorities?
2. Discuss which ecosystem services would or wouldn't be affected by removal of biomass.

C. How biomass removal can affect fire management

1. Discuss fire management strategies (prescribed and controlled burning, fuel removal) and fire ecology (fire triangle, types of fires, ladder fuel).
2. Hypothesize about which of the two areas sampled would be more prone to destructive fires.

F. Other than the vegetative structure of a forest, what other factors might come into play when evaluating the suitability of a site for biomass removal? (5 minutes)

1. Already existing infrastructure
2. Cultural and societal resources
3. Etc.

During the activity, move between groups to see that the students understand what they are doing and to answer any questions they might have.
After the data has been collected and the slash per acre has been estimated, have each group present their findings to the rest of the class. Have students reflect on the following questions:

- Which sample area (per acre) was estimated to contain more slash weight?
- How did the areas differ in the nature of the slash present (location, size, concentration, etc.)?
- How might the differences in slash affect the ecology of the sample areas?
- What were the easiest/most difficult parts of the activity?
- What flaws did you discover/might you expect from random sampling methods like the one used in this activity?
- In timber harvest, what might be the benefits and risks associated with extracting more slash than we have been able to in the past?

Evaluation:

On the hike back, assess each student's knowledge by casually asking students to identify trees that were learned during the activity. Ask: what tree is this and how do you know?

Additional resources:

Brown, J. K. et al. 1977. Handbook for predicting slash weight of western conifers. USDA Forest

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Service. General Technical Report INT-37. <http://www.fs.fed.us/rm/pubs_int/int_gtr037.pdf>

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Brown, J. K. et al. 1977. Handbook for predicting slash weight of western conifers. USDA Forest Service. General Technical Report INT-37. <http://www.fs.fed.us/rm/pubs_int/int_gtr037.pdf>

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Directions for Slash Activity

1. Randomly determine a point at which to begin their sample plot. To do this, wander a ways into the plot. Then, to determine an azimuth, look at the watch and prepare to walk in the direction that the second hand points toward at that given moment. Determine a technique for randomly generating a value for the number of paces to walk in that direction (e.g., take the tallest person and ask them their birthday, then take the same number of paces as the day they were born). Mark the point with a flag.

2. From that point, use the meter tape and the compass to measure 6.63 meters north, and mark that spot with another flag. From there, measure 6.63 meters west and place a flag, then 6.63 meters south and place a flag. The resulting flags mark the corners of a square sample plot that is 1/10 of an acre in surface area.

3. Sample all trees that lie in the sample location and are greater than 1 inch in diameter at breast height (DBH). For trees that lie partially in the plot and partially out (the borderline of the plot transects the bole of a tree) count every other tree.

4. For each tree in the sample plot, measure DBH using the DBH tape, and determine species using the tree finder. Record DBH and species of each tree in the data table provided.

5. Rotate jobs (i.e., species identifier, DBH measurer, recorder of data, and recorder of which trees to include and which were already sampled) amongst group members.

6. Calculate the *estimated slash per tree* by referring to the FS Slash Weight Table (appendix b), and record on data table.

7. Estimate and record the *total slash per sample plot* by taking the sum of the *estimated slash per tree* values.

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8. Estimate and record the *total slash per acre* by multiplying the *total slash per sample plot* by 10.

9. Move to sample area 2 and repeat

Data Recording Table (1 per sample area)

DBH	*Species*	*Estimated Slash per Tree*
	*Total Estimated Slash per Sample Plot (*sum of *Estimated Slash per Tree* values) →	
	Total Estimated Slash per Acre (Slash per Sample Plot x 10) →	

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Reflection Questions

1. Which sample area (per acre) was estimated to contain more slash weight?

2. How did the areas differ in the nature of the slash present (location, size, concentration, etc.)?

3. How might the differences in slash affect the ecology of the sample areas?

4. What flaws did you discover/might you expect from random sampling methods like the one used in this activity?

Slash Weight Per Tree Table

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D.b.h. (inches)	Species							
	PP	LP	WL-WP	DF	GF	AF	WC-WH	ES
	Pounds							
1	1.3	1.1	1.8	3.1	3.7	8.6	2.2	2.8
2	5.7	4.3	5.5	9.4	11.3	12.4	7.3	9.3
3	13.3	9.4	10.7	18.0	21.9	18.8	14.5	18.6
4	24	17	17	29	35	28	24	30
5	39	26	24	41	51	40	35	45
6	58	37	33	55	69	55	48	61
7	80	51	42	71	90	73	63	80
8	106	67	53	89	113	94	79	101
9	137	85	64	109	139	119	97	125
10	171	106	76	130	168	149	117	150
11	210	127	89	153	200	182	139	178
12	254	150	103	178	236	221	162	208
13	302	174	117	204	275	265	188	240
14	354	200	133	233	317	314	215	275
15	411	228	149	263	364	370	244	312
16	473	258	166	295	416	433	274	352
17	540	289	183	329	471	485	307	395
18	611	322	202	375	532	542	341	439
19	688	356	221	424	581	603	378	487
20	770	392	241	476	631	667	416	538
21	856	430	261	532	683	735	456	591
22	949	469	283	591	736	805	499	648
23	1,050	510	305	654	790	879	543	708
24	1,150	553	328	720	846	957	590	771
25	1,260	597	351	790	903	1,040	639	837
26	1,370	642	375	864	962	1,120	690	907
27	1,490	690	400	941	1,020	1,210	743	980
28	1,620	739	426	1,020	1,080	1,300	799	1,060
29	1,750	789	452	1,110	1,150	1,390	857	1,140
30	1,880	841	479	1,200	1,210	1,490	917	1,220
31	2,030		506	1,290	1,280		980	1,310
32	2,170		535	1,390	1,340		1,040	1,410
33	2,330		564	1,490	1,410		1,110	1,500
34	2,490		593	1,590	1,480		1,180	1,610
35	2,660		624	1,700	1,550		1,260	1,720
36	2,830		655	1,820	1,620		1,330	1,830
37	3,010		686	1,930	1,700		1,410	1,950
38	3,190		719	2,060	1,770		1,490	2,070
39	3,390		752	2,190	1,850		1,570	2,200
40	3,580		786	2,320	1,920		1,660	2,330

1/ Numbers within the lined space are within limits of data sampled.

PP-ponderosa pine, LP-lodgepole pine, WL-WP-western larch and western white pine, DF- Douglas fir, GF-grand fir, AF-subalpine fir, WC-WH-western redcedar and western hemlock, ES-Engelmann Spruce

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