Table 1. Information about organisms in Flathead Lake ecosystem. (Based on *The Great Flathead Lake Ecosystem Mystery* by Dan O'Brien and David Fitzpatrick.)

Organism	**Information**
Bald eagles *Haliaeetus leucocephalus*	Up to 230 cm (90 in) wingspan. Requires 4-5 years to reach adult plumage. Almost entirely piscatorial (fish-eating). From a peak of 644 birds in October 1981, eagle sightings fell to a low of 7 in 1993.
Kokanee Salmon *Oncorhynchus nerka*	These landlocked versions of the sockeye salmon were introduced to Flathead Lake in 1916. They grow 3-4 years before spawning in November and December in the gravels along shorelines or up nearby streams. Preferred spawning stream was McDonald Creek in Glacier National Park. Over 9 million fry were produced each year. Kokanee were so common that the daily catch limits were 70 fish per person per 2 days and overall annual catch totals exceeded 100,000 animals, removing up to 50% of the adult population each year. Kokanee are visual predators with small mouths and prefer to feed on the largest zooplankton. Feeding occurs during the day in the upper 30 meters of the water column.
Lake Trout *Salvelinus namaycush*	Native to St. Mary and Waterton Lakes to the north, Lake Trout were first introduced to Flathead Lake in 1890. Young fish (age 1-2) have been found with their stomachs gorged with Mysis shrimp. When they reach 2 or 3 lbs in weight, their diet is largely fish such as minnows, whitefish, and small salmonids. They spawn in the lake itself during October and November.
Lake Whitefish *Coregonus clupeaformis*	Thought to be native to St. Mary Lake and Waterton Lake, these have been planted in Flathead Lake many times since about 1900. Whitefish spawn in the lake from October to January. Whitefish feed largely upon zooplankton during their first two years. Adults, however, become very predacious on young fish of other species, *Mysis* shrimp, as well as benthic (bottom-dwelling) invertebrates like midge larvae, clams and amphipods.
Bull trout *Salvelinus confluentus*	Native to Flathead Lake. Bull trout spawn in the lake but seem to prefer small streams. These opportunistic fish will feed on nearly any available organism of appropriate size, although for adults, the principle food tends to be other fish. Younger fish prefer aquatic insects. This species is of cultural significance to local tribes on the Flathead Indian Reservation.
Cutthroat Trout *Oncorhynchus clarkii lewisi*	Native to Flathead Lake, they tend to be limited to certain streams and often only to the headwaters. Cutthroat trout do not migrate to the lake until the age of 2 years. They are springtime spawners in the rivers that feed the lake. Young fish feed primarily on zooplankton while adults prefer aquatic insects and occasionally juvenile members of their own species.
Opossum Shrimp *Mysis relicta*	Introduced into Ashley and Whitefish lakes in 1968, and into Swan lake in 1975. First appeared in Flathead Lake in 1981. Due to photoinhibition, they prefer to inhabit the cold water at the bottom of the lake at depths below 30

	meters by day. At night, they migrate upward to feed in the slightly warmer upper water layers, but stop short of the warmest upper layers during the summer. They are opportunistic feeders that consume phytoplankton, zooplankton and whatever other organic debris may be present in the water column. *Mysis* die quickly at temperatures over 15 degrees C.
Cladocerans *Daphnia longiremis, Daphnia thorata, Bosmina longirostris*	Zooplankton – "Water fleas" Prefer warmer surface waters. Opportunistic feeders that consume phytoplankton, smaller zooplankton and whatever organic debris might drift nearby.
Primary Productivity	Phytoplankton (algae) prefer warmer surface waters close to the light source. As a measure of productivity, researchers check the rate at which the phytoplankton remove carbon from the environment. They also determine the amount of chlorophyll a in a phytoplankton sample as an indicator of the productivity in a study area.

Table 2. Data from 1979 to 1997 of upper trophic levels in Flathead Lake. Native organisms are highlighted in blue and non-native organisms are highlighted in yellow. Missing data indicates that no data was collected that year. (Based on *The Great Flathead Lake Ecosystem Mystery* by Dan O'Brien and David Fitzpatrick.)

Year	Bald eagle	Kokanee salmon	Lake whitefish (#/net)	Lake trout (#/net)	Bull trout (#/net)	Cutthroat trout (#/net)
79	525	67000				
80	364	49000				
81	644	108000	3.2	0.04	2.6	0.1
82	322	30000				
83	259	33000	2.1	0.1	1.6	0
84	616	90000				
85	525	123000				
86	210	25000				
87	70	500				
88	56	0				
89	25	0				
90	21	200				
91	21	0	25.7	7.6		
92	14	0	11.4	1.7	0.5	0
93	7	0	7.7	1.4	0.1	0.1
94	~0	0	15.4	3.1	0.2	0
95	~0	0	7.0	1.2	0.0	0
96	~0	0	7.1	1.3	0.1	0
97	~0	0	12.3	1.7	0.2	0

Table 3. Data from 1979 to 1997 of lower trophic levels in Flathead Lake. Native organisms are highlighted in blue and non-native organisms are highlighted in yellow. Missing data indicates that no data was collected that year. (Based on *The Great Flathead Lake Ecosystem Mystery* by Dan O'Brien and David Fitzpatrick.)

Year	Primary productivity ($gC/m^2/day$)	*Mysis* shrimp ($\#/m^2$)	Cladocera (#/L) (*Daphnia longiremis)*	Cladocera (#/L) (*Daphnia thorata)*	Cladocera (#/L) (*Bosmina longirostris)*
79	280	0.0			
80		0.0			
81	704	0.0			
82	431	0.0			
83	253	0.3			
84	335	2.5	1.9	1.3	
85	492	49.3	1.6	0.8	
86	398	129.0	0	0.7	
87	519	108.0	0	0.7	0.6
88	693	53.1	0		
89	442	27.0	0	0.9	0.5
90	462	37.4	0		
91	583	16.1	0	0.8	0.1
92	546	28.6	0	1.0	0.2
93	470	18.8	0		
94	425	26.3	0	2.3	0.5
95	440	42.0	0		
96		40.8	0		
97		68..3	0		

Table 4. Job descriptions for pinwheel discussion.

Tribal Council page 1

Article VI - Powers and Duties of the Tribal Council

Section 1. The Tribal Council shall have the power, subject to any limitations imposed by the Statutes or the constitution of the United States and subject to all express restrictions upon such powers contained in this Constitution and attached Bylaws;

(a) To regulate the uses and disposition of tribal property, to cultivate Indian arts, crafts, and culture, to administer charity; to protect the health, security, and general welfare of the Confederated Tribes.

(b) To employ legal counsel for the protection and advancement of the rights of the Flathead confederated Tribes and their members, the choice of counsel and fixing of fees to be subject to the approval of the Secretary of the Interior. (Maybe)

(c) To negotiate with the Federal, State, and local governments on behalf of the confederated Tribes, and to advise and consult with the representatives of the Departments of the Government of the United States on all matters affecting the affairs of the Confederated Tribes.

(e) To advise with the Secretary of the Interior with regard to all appropriation estimates or Federal projects for the benefit of the Confederated Tribes, prior to the submission of such estimates to the Congress.

(h) To appropriate for tribal use of the reservation any available applicable tribal funds, provided that any such appropriation in excess of $25,000 shall be subject to review by the Secretary of the Interior.

(j) To exclude from the restricted lands of the reservation persons not legally entitled to reside thereon, under ordinances which may be subject to review by the Secretary of the Interior.

(o) To charter subordinate organizations for economic purposes and to regulate the activities of all cooperative and other associations which may be organized under any charter issued under this Constitution.

(p) To regulate the inheritance of real and personal property, other than allotted lands, within the Flathead Reservation, subject to review by the Secretary of the Interior.

http://www.csktribes.org/component/rsfiles/download?path=Tribal%2BCouncil%252FCSKT%2BConstitution%2Band%2BByLaws.pdf

Cultural traditions rely on abundant populations of native fish and wildlife, healthy plant communities, clean air and water. Undisturbed spiritual sites, prehistoric and historical campsites, dwellings, burial grounds and other cultural sites are important, too, because they, in the words of the Flathead Culture Committee, "reaffirm the presence of our ancestors, how we are alive today only because of them. These places are part of the basis of our spiritual life." They provide young people with a connection to ancestors and native traditions.

Many food and medicinal plants grow on Reservation and aboriginal lands. Some grow in mountain areas, others along river and stream corridors, still others in arid places. Many have multiple uses. The Tribes have used most of them for thousands of years.Tribal elders report that some human activities, such as logging and grazing, have damaged some of the areas where these plants grow. Work is ongoing to protect these sites.

There are other cultural resources on the Reservation and aboriginal lands that must be protected. These include hunting and fishing grounds, spiritual sites, dancing grounds, trails, and occupational sites. Salish and Kootenai cultural resource specialists use the term “site” for areas of historical, cultural or spiritual importance. These areas sometimes, but not always contain artifacts. They may be the site of past or present-day Tribal activities.

“Many cultural resources are non-renewable resources. They can be one day or thousands of years old. Their destruction is a gross violation of everything we value.”

— Flathead Culture Committee

Cultural resources are precious Tribal resources. They encompass the Tribes’ elders, languages, cultural traditions, and cultural sites. They include the fish, wildlife and plants native to the region and land forms and landmarks. Tribal elders and the languages are perhaps the most vital of these resources because they teach and communicate the histories and traditional lifestyles of the Tribes. The traditions depend on land based cultural resources. These land-based resources include native fish and wildlife and their habitats, food and medicinal plants and the areas where they grow, prehistoric and historical use sites, and other land areas where Tribal members currently practice cultural traditions.

The Tribes believe everything in nature is embodied with a spirit. The spirits are woven tightly together to form a sacred whole (the Earth). Changes, even subtle changes that affect one part of this web affect other parts. Protecting land-based cultural resources is essential if the Tribes are to sustain Tribal cultures. This is one of the most important goals of Tribal natural resource management on the Reservation. It is also a goal that the Tribes have for Tribal aboriginal territories managed by other entities.

http://www.csktribes.org/CSKTClimatePlan.pdf

The Confederated Salish and Kootenai Tribal Natural Resources Department is comprised of three Divisions. The Division of Environmental Protection, the Division of Fish, Wildlife, Recreation, and Conservation, and the Division of Water. The Department is home to over 140 employees located in three facilities within the communities of Ronan, and Polson, MT.

The Natural Resources Department Ordinance 78B is an umbrella ordinance that defines the overall policy of natural resource management on the Flathead Reservation.
The ordinance states: It is the purpose and policy of the Tribal Council of the Confederated Salish and Kootenai Tribes of the Flathead Reservation (to)

1. define and manage the natural resources of the Flathead Reservation to the benefit of the members of the Confederated Salish and Kootenai Tribes and, thereby, of all the residents of the Flathead Reservation;
2. maintain a careful balance between the development of and the protection of natural resources on the Flathead Reservation;
3. direct and coordinate all feasible technical and administrative expertise toward sound natural resource management on the Flathead Reservation.

The ordinance also describes the organizational structure, duties, powers and special functions of the Tribal Natural Resources Department.

Division of Environmental Protection

"To advocate for the protection, restoration, effective management and health of the air, land, water and biological resources of the reservation environment through education, planning, conservation, cooperation and regulation. While perpetuating cultural values and the quality of life of the people of the Flathead Indian Reservation."

Division of Fish, Wildlife, Recreation and Conservation

"To protect and enhance the fish, wildlife and wildland resources of the Tribes for continued use by the generations of today and tomorrow."

Division of Water

“The general mission of the Division of Water is to provide technical and administrative support to protect and enhance the water resources and other resources on the Flathead Reservation for future generations.”

http://nrd.csktribes.org/home/about-nrd

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http://www.csktribes.org/CSKTClimatePlan.pdf

Montana Department of Natural Resources and Conservation

The mission of this department is to help ensure that Montana's land and water resources provide benefits for present and future generations.

Our Trust Lands Management Division oversees 5.2 million acres of state trust land. Through programs including sustainable forestry, agriculture, grazing and energy leasing, we generate millions of dollars annually for K-12 public education, including school facilities and classroom technology. Montana's Trust Lands are a vital component of local economies and also provide tremendous recreation opportunities for hunters, anglers, hikers and horseback riders

The Water Resources Division is responsible for managing Montana's water for the present and future needs of its people. We compile accurate, up-to-date stream flow data from more than 90 monitoring gages, providing critical data for managing reservoirs, irrigation schedules, water rights permitting and adjudication, floodplain management and other services for farmers, ranchers, citizens and communities. We also manage the operation and maintenance of 24 state-owned dams and 250 miles of irrigation canals.

Based in Missoula, the Forestry Division promotes responsible and proactive stewardship of Montana's forests and rural lands. Our programs help private landowners manage their forested lands, and help cities and towns develop vibrant parks, boulevards and natural areas. We respond to wildfires, insect pests and diseases, and advocate for sustainable forest management practices on private, state, tribal and federal forestlands. We value Montana's integrated forest industry and its social, economic and environmental benefits.

Through regulation and remediation, the Montana Board of Oil and Gas Conservation protects citizens and the environment from the impacts of oil and gas activities. The Board is responsible for permitting all oil and gas wells and regulates the underground injecting program. Staff identify projects and hire contractors for remediation efforts such as plugging orphaned wells and restoring abandoned well sites. The Board is also responsible for inspecting oil and gas wells and operations to ensure they comply with all state environmental laws.

An essential component of Montana's ongoing adjudication of water right claims includes quantifying the federal reserved water rights held by Montana Indian tribes and federal agencies. The Reserved Water Rights Compact Commission negotiates settlements with Tribal and federal stakeholders, providing all Montana water users with a degree of certainty regarding current and future water rights. The negotiation process gives all citizens a voice in how the water compacts are written.

http://dnrc.mt.gov/

Montana Fish, Wildlife, and Parks

These are some of the core values of the department.

- Serve the Public
    - We strive to meet public expectations for fish, wildlife, and state parks resource conservation, access, opportunity, services, fiscal responsibility, and involvement in transparent decision-making processes.
- Embrace the Public Trust
    - We recognize that Montana's fish and wildlife are the public's resources and are held in trust by the state to be managed for the benefit of present and future generations. The opportunity to enjoy and harvest these resources is allocated equitably.
- Honor Tradition and Heritage
    - We value the continued importance of hunting, fishing, trapping, and other outdoor recreation to Montana's culture and conservation ethic. We honor the cultures of native peoples and value Montana's vibrant history.
- Work with Landowners
    - We respect property rights and work collaboratively with landowners to manage fish, wildlife, and state parks resources and the public's opportunity to enjoy them.
- Use Science
    - We use the best biological and social sciences to inform and make management decisions.
- Provide Leadership
    - We provide expertise and direction in fish, wildlife, and state parks outdoor recreation, resource management, and conservation to enhance Montana's outdoor heritage, economic future, and quality of life.
- Provide Stewardship
    - We manage for healthy and abundant fish and wildlife populations, improve and protect habitat, and protect and restore cultural and historical resources.

http://fwp.mt.gov/doingBusiness/insideFwp/visionAndGuide/

Table 5. NGSS Standards Performance Expectation

HS-LS-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. [Clarification statement: Emphasis is on quantitative analysis and comparison of relationships among interdependent factors, including boundaries, resources, climate, and competition. Examples of mathematical comparisons include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.]
HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales [Clarification statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple data sets.]
HS-LS2-6. Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. [Clarification statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood, and extreme changes, such as volcanic eruption or sea-level rise.]
HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* [Clarification statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.] *This performance expectation integrates traditional science content with engineering through a practice or disciplinary core idea.*

Table 6. Montana Office of Public Instruction Indian Education for All Essential Understandings

Essential Understanding 1. There is great diversity among the twelve sovereign tribes of Montana in their languages, cultures, histories, and governments. Each tribe has a distinct and unique cultural heritage that contributes to modern Montana.
Essential Understanding 2. Just as there is great diversity among tribal nations, there is great diversity among individual American Indians as identity is developed, defined, and redefined by entities, organizations, and people. There is no generic American Indian.
Essential Understanding 3. The ideologies of Native traditional beliefs and spirituality persist into modern day life as tribal cultures, traditions, and languages are still practiced by many American Indian people and are incorporated into how tribes govern and manage their affairs. Additionally, each tribe has its own oral histories, which are as valid as written histories. These histories predate the “discovery” of North America.
Essential Understanding 7. American Indian tribal nations are inherent sovereign nations and they possess sovereign powers, separate and independent from the federal and state governments. However, under the American legal system, the extent and breadth of self-governing powers are not the same for each tribe.

Table 7. Connections to the Common Core State Standards (NGAC and CCSSO 2010)

ELA
CCSS.ELA-Literacy.RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
CCSS.ELA-Literacy.RST.9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
CCSS.ELA-Literacy.RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
Mathematics
HS.MP.2 Reason abstractly and quantitatively.
HS.MP.3 Construct viable arguments and critique the reasoning of others.
HS. MP.4 Model with mathematics.

Table 8. Rubric for Flathead Lake data analysis project

Part	0 points	10 points	20 points	30 points
Food Web	No food web was not completed.	Food web had 3-5 of the organisms and showed incorrect or missing connections.	Food web had 6-8 of the organisms and showed incorrect or missing connections.	Food web had all 9 organisms and all connections were correct.
Graphs	Graphs were not completed.	One graph was created and labeled correctly OR two graphs were created but were labeled incorrectly.	Two graphs were created and labeled correctly OR three graphs were created but were labeled incorrectly.	Three graphs were created and labeled correctly (axis labels and complete title, showing place, organism, and time).
Summary Essay	Summary essay was not completed.	Summary essay was inaccurate and did not explain what happened with the ecosystem.	Summary essay was accurate in implicating the *Mysis* shrimp but did not show all of the cause and effect relationships that occurred in the ecosystem.	Summary essay accurately implicated the *Mysis* shrimp and explained the complex cause and effect relationships.
Proposal Essay	Proposal essay was not completed.	The proposal essay was present but not thorough and did not provide pros and cons.	Proposal essay was thorough but did not provide pros and cons.	Proposal essay provided a thorough and comprehensive solution and included pros and cons.

Table 9. Rubric for Flathead Lake pinwheel discussion

Part	0 points	10 points	20 points
Perspective	Student did not provide their group's perspective.	Student briefly provided their group's perspective.	Student thoroughly and clearly explained their group's perspective.
Counterpoints	Student did not provide counterpoints.	Student provided one poorly developed counterpoint.	Student provided many well-developed counterpoints.
Invited others in	Student did not invite others into the discussion.	Student attempted to elicit conversation from the other member of the pinwheel round.	Student consistently invited others in the pinwheel into the conversation and found ways to connect the topic to other stakeholders.
Consideration of other perspectives	Student did not consider the perspective of others or was defensive.	Student respected the perspectives of the other stakeholders.	Student was aware of the perspectives of the other stakeholders and sought to find compromises that would honor all parties when there were disagreements.