Xa'at Atwu Wei Aaskwani: Salmon in the Trees

A Science Literacy Unit for High School: Teacher Edition

Photo Credit: 2013 GHF Path to Excellence Academy

Xa'at Atwu Wei Aaskwani: Salmon in the Trees
Place-based learning extensions for a high school ecology class

Introduction to Place-Based Education-Written By Paul K. Berg
Alaskan public education has historically excluded Native culture and knowledge from the curriculum. In the last decades of the 20th century, the education system strove to appear outwardly sympathetic towards Alaska Native cultures, but remained structurally resistant to Native ways of knowing (Thornton, 2008 Oxford University's Place as Education's Source). However, we are beginning to realize that no one culture has a monopoly on reality. To ignore the ancient wisdom of those who have lived and prospered in this challenging environment for thousands of years is to court disaster.

An excellent way of making schooling more relevant to Alaska Natives and to all students, is to integrate the knowledge from both Native and Western cultural traditions. According to Thomas F. Thornton of Oxford University, this is achieved by broadening cultural standards, emphasizing Native ways of knowing, and investing in place based education. To the Tlingit, maintaining sense of place is part of the foundation for culture and well-being. Ninety percent of the Native students in Juneau will not permanently leave Southeast. This is their home. They are here to stay. They need to be grounded in the history, science, ecology, and mathematics of this land, the place where they live and call home.

For those of us who are non-Native, teachers and students alike, place based education allows us to learn the land-based knowledge and skills which have enabled Alaska Natives "to dwell sustainably in the the 'Last Frontier' over millennia." (Thornton, 2008). The Tlingit and Haida understood the importance of managing resources in harmony with the ecological systems and the communities that depended on them. We have much to learn from this knowledge base. By combining knowledge from both cultural traditions, we can achieve new insights and become better stewards of this great land.

The following locally-based instructional unit provides an opportunity to re-align a small part of the curriculum "to center on the process of becoming native to this place" (Thornton, 2008). The lessons are cross-cultural experiences for Native and non-Native students alike. They present new ways of learning, new ways of understanding, and new ways of knowing. Yet each of the lessons teach sills which are part of the Juneau Borough School District's curriculum and Next Generation Science Standards. The major change is that the subject is not disembodied facts in a textbook. The subject is the place we call our home.

Unit Overview:
Juneau students live in two worlds. The first world is a small town with the amenities and services which would be the pride of many larger cities. Yet, they can walk out their front door or take a short boat ride and enter a second world—the Tongass National Forest. The Tongass is a world treasure, encompassing a third of the earth's remaining temperate rain forest. The abundance life—humpback whales, sea lions, orcas, wolves, eagles, bears, salmon, and trees combine to create one of the most unique ecological systems on earth.

The following Learning Extensions are place-based activities designed to supplement the Ecology Unit, Chapters 3 through 6, of the 2010 edition of the Miller and Levine Biology textbook. These materials enable the teacher to select additional learning activities which are thematically

consistent with Biology text and specific to Southeast Alaska. The learning extensions activities can be used supplement the existing science coursework, as enrichment activities in Biology and General Science courses, or as stand-alone activities in summer science classes and cultural camps. Culturally responsive standards are incorporated into the content of the chapter extensions.

The Learning Extensions approach Ecology from two cultural perspectives—Western scientific biological knowledge and traditional Tlingit knowledge of the natural world. The activities are designed to lead students to better understand and appreciate the fragile balance of life which makes up the ecosystem of Southeast Alaska.

The extension activities reflect the Tlingit belief that a sense of place is the foundation of culture and wellbeing. Knowledge about place, and respect for place are both necessary for a person to live a healthy, well balanced life. Based on these cultural beliefs, these materials have been developed by the Goldbelt Heritage Foundation for all students in the Juneau schools to use and enjoy.

The Importance of Wild Salmon

There are three sources of salmon on the world market. Wild salmon are caught by subsistence, sport, and commercial fishers. The second source of salmon is the farmed salmon, raised in salmon pens. The third source consists of the salmon raised in fish hatcheries and released as fry into the natural environment.

Wild salmon are the most valuable source of salmon. Wild salmon are healthy fish which have lived a normal life and feed off the natural environment. Also, wild salmon bring back nutrients from the ocean to the land to feed the animals such as eagles and bears. The wild salmon nourishes the forest ecosystem.

Farmed salmon do not nurture the forest. Farmed fish are raised in pens, an unnatural environment which artificially stresses the fish, similar to cattle being raised and fed in feed lots. Also, farmed salmon are fed with artificial nutrients, medications, and additives. Farmed fish outsells wild salmon, but do not have the environmental, nutritional, nor cultural value of wild salmon. The term “organic salmon” can only be used on the packaging of farmed fish, raised in a closed system. This label is misinterpreted by many consumers. Wild salmon are not considered “organic.”

Hatchery salmon are in between these two extremes. They live in the natural ecosystem, but they return to a hatchery. They do not come back to the land and nourish the forest. They return to a terminal harvest in a hatchery. Twenty-one percent of the salmon commercially caught in Southeast are from fish hatcheries.

The Tongass National Forest generates the healthiest wild remaining salmon runs in the world. The Tongass is basically healthy. During 2010 and 2011 Southeast Alaska experienced record salmon runs. The Tongass is America’s salmon forest.

Source: Ron Medel, Tongass Fisheries Program Manager

How to Use this Unit

The following instructional unit can be used to add to an already existing high school ecology course.

1. As an integral part of the existing high school ecology or environmental science course.
2. A supplement to a middle school life science course.
3. In summer schools and day camps.

Teachers are encouraged to expand the lessons by bringing in outside resource people such as biologists, traditional Native Elders with knowledge of local edible and medicinal plants, or knowledgeable people who have experience with temperate rainforests. An excellent source of additional information about the historical harvesting of plants is the USDA *"Haa Atxaayi Haa Kusteeyix Sitee, Our Food Is Our Tlingit Way of Life-Excerpts from Oral Narratives."*

Tlingit Educational Elements

This unit will focus on two Tlingit elements: *ecological literacy* and *societal context*. Students will build background knowledge as they meet and listen to elders and community professionals, read informational and narrative text, study local harvest gear and techniques, practice traditional processing and preservation techniques, conduct scientific experiments, recognize invasive species, and prepare a food plan and letter of recommendation as the culminating activity to address the essential questions:

- What are the connections between people, plants, other animals, and the physical universe? (adapted from Inupiaq Learning Framework-Environment)

Tlingit Elder Role

In Alaska, experience matters. The Southeast Alaska environment can be hard and unforgiving for the novice. Those who have spent a lifetime living and working outdoors in Southeast have gained valuable skills and insights which can be passed on to the younger generation. The Learning Extensions provide opportunities for involving Elders and Knowledge Bearers to share their knowledge in an educational setting. Consider inviting these people--parents, grandparents, neighbors--to the class to share their knowledge about Southeast, and especially about the changes they have observed in wildlife and plants in and near Juneau over the years.

Why Use Oral Narratives?

Tlingit oral narratives contain many layers which enrich our knowledge and imagination. On one level, these stories are great entertainment. Some Tlingit narratives explain how aspects of our world came to be. Other oral narratives relate epic adventures of specific clan ancestors. Stories involving Raven often include humorous exploits which may lead us to reflect upon respectful treatment of others. However, oral narratives were not told solely for entertainment.

In the past, oral narratives were used to convey many forms of knowledge. They taught about place names, property, geography, and science. From these stories, younger generations would learn about food preparation, the ebb and flow of the tides, and behavioral patterns of hunted mammals. Many of these stories assisted in the teaching of life skills such as navigation an obtaining food from the land. In addition, oral narratives were used to convey traditional values and social responsibility: They explore human nature and may involve concepts of identity, alienation and isolation, coming of age, loyalty, pride, loss, and other conflicts humans experience throughout life. These stories are spiritual, intellectual gifts which have been passed down from esteem ancestors. Like all good literature, Tlingit oral narratives can be used to enhance content learning in the classroom. These stories can be used as a springboard to teach history, geography, science, mathematics, Tlingit heritage language, reading, writing, and more.

Note: *Tlingit oral narratives are the property of specific clans. For many stories, permission is needed before they are used in the classroom.*

Overview of Lesoons	Literacy Strategies	Academic Vocabulary	Assessments
Lesson 1: Alive in the Eddy Students will read together the Tlingit oral narrative, the Salmon Boy Story and examine the narrative for ecological insights. Using a display map of SE Alaska, sutdents will collectively share their thoughts about the meaning of the story and the ecological uniqueness of SE Alaksa.	• Close reading • Visualization	• ecology • ecological niche • biosphere	• Journal prompt • Class discussions
Lesson 2: Salmon in the Trees Using Amy Gulick's book, Salmon in the Trees and the 10 minute video with the same title, students explore the complex relationship that exists between salmon and the rainforest. Students write about the uniqueness of the temperate rainforest and construct a southeast forest food web.	• Quick write • Reread • Activating prior knowledge	• biomass • food chain • food web • producer • consumer	• Pre-assessment • Journal prompt • Class discussions
Lesson 3: Five Species of Alaska Salmon To introduce students to concepts of plant systems including plant structure and function, photosynthesis, and reproduction with a concluding ecological survey of a local area.	• Quick write • Graphic organizer • Activating prior knowledge • Chunking the activity	• dorsal fin • adipose fin • caudal fin • pectoral fin • operculum	• Journal prompt • Salmon ID notes • Class discussions • Group presentations
Lesson 4: Salmon Project Students will learn to identify the five species of Pacific salmon and the potentially invasive Atlantic salmon. Students will learn about the unique characteristics of the various Pacific salmon species and investigate environmental, commercial, and social issues which affect the health and sustainability of salmon runs in Southeast and throughout Alaska.	• Peer reflections • Close reading • Generating questions • Summarizing	• respect • woocheen	• Post-assessment free response • Final presentation

Standards Addressed in this Unit

Next Generation Science Standards & Alaska Standards for Culturally-Responsive Schools

NGSS Performance Expectations

HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem

LS2.B. Cycles of Matter and Energy Transfer in Ecosystems

Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)

HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

LS2.A: Interdependent Relationships in Ecosystems

Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1),(HS-LS2-2)

Cultural Standards for Students

A.7. Determine the place of their cultural community in the regional, state, national, and international political and economic systems

B.3. Make appropriate choices regarding the long0term consequences of their actions

D.1. Acquire in-depth cultural knowledge through active participation and meaningful interaction with Elders

E.2. Understand the ecology and geography of the bioregion they inhabit

Cultural Standards for Educators

A.1. Utilize Elders' expertise in multiple ways in their teaching

A.3. Provide opportunities for students to learn through observation and hands-on demonstration of cultural knowledge and skills

B.1. Regularly engage students in appropriate projects and experiential learning activities in the surround environment

D.3. Seek to continually learn about and build upon the cultural knowledge that students bring with them from their homes and community

VOCABULARY FOR LEARNING EXTENSIONS 1 THROUGH 4

- Biosphere: the parts of the Earth on which life exists including land, water and atmosphere
- Biomass: total amount of living mass within a given trophic level (i.e. step of the food chain
- Consumer: organism which relies on other organisms for it energy and food supply
- Producer: an organism capable of producing its own food through either photosysthesis or chemosysthesis, producers are usually at the lowest levels of the food chain
- Ecology: scientific study of the interactions among organisms and between organisms and their environment
- Food Chain: a series of steps in an ecosystem in which organisms transfer energy by eating and being eaten
- Food Web: a network of complex interactions formed by the feeing relationships among the various organisms in an ecosystem
- Ecological Niche: the place where an organism lives and the role the organism plays within its habitat
- Food Sovereignty: the right of people to define their own food systems; advocates of food sovereignty put the individuals who produce, distribute, and consume food at the center of decisions on food systems and policies rather than corporations, governments, and market institutions
- Ecological Footprint: the total amount of functional ecosystem needed both to provide the resources a human population uses and to absorb the wastes that population generates
- Dorsal fin: the large rayed fin located on the back of salmon and other salt and fresh water vertebrates
- Adipose fin: a soft fleshy rayless modification of the posterior dorsal fin found in certain fishes including salmon, frequently removed to mark hatchery raised salmon
- Caudal fin: the tail fin of a fish
- Pectoral fin: the two fins located behind the head of a fish or whale, pectoral fins are in the same location as the forelimbs of a mammal
- Operculum: the hard bony flap covering the gills of a bony fish

Lesson 1
Alive in the Eddy

Purpose
To introduce and elaborate upon ecological concepts and definitions through place-based knowledge; to introduce students to Tlingit oral narratives; to draw conclusions about stewardship and management through Tlingit culture; to identify environmental factors which contribute to Southeast Alaska's unique ecosystems.

Essential Question
- What ecological and cultural factors make Southeast Alaska unique?

Duration
1 (75-minute sessions)

Academic Vocabulary
- Biosphere, biomass, ecology, ecological niche, dorsal fin

Materials & Preparation
- Student composition notebooks
- Student page-Copy of *Alive in the Eddy*
- A map of Southeast Alaska

Suggested Guests
- A Tlingit elder or specialist to tell the students *Salmon Boy*

Literacy Strategies
- Close reading, visualization

Assessments
- Journal prompt
- Class discussions

Procedure
Step 1) Introducing Content
- Tell students that you are going to read a traditional Tlingit story to the class. The Tlingit used stories as teaching tools to train young people about proper behavior and attitudes towards the natural world. Ask students to listen carefully to identify what the story is attempting to teach the listeners.

TRADITIONAL TLINGIT WISDOM

The Eagle Boy Harvest story this unit refers to is from the Haa Atxaayí Haa Kusteeyíx Sitee, Our Food is Our Tlingit Way of Life (pages 32-34) as compiled by Richard G. Newton and Madonna L. Moss and as told by John C. Jackson of Kake. The story is property of the Wooshkeetaan clan of Aak'w Kwáan.

"This is the story of an orphan boy. Eagles build their houses in trees; people call them eagle nests because in the eyes of human beings it is a nest. To the eagles it is a house and a home."

T*here was a young boy who became an orphan. His father and mother died, all his uncles also. He had only one pair of grandfolks still living. They were quite old and not able to get around, but they were his only living relatives, so they looked after him. As he grew old enough he was able to get around and he realized he would have to do something for them because there were so old. If they were going to eat, he would have to get some food. So one of the first things he did was to look around. Out in the vicinity of Auke Village there was a reef. While rowing around there one day he discovered there was food there and he gathered some up and brought it ashore. His grandfolks thought this was wonderful, so in turn, they told him to be very careful. They instructed him to always tie the rope around his waist, which he did religiously.*

One day the leather used for rope somehow untied itself from the bow of the boat. The other end was still attached to his waist. When he discovered the canoe had floated quite a ways from him, he did not know what to do. He was a small boy and did what was natural for a boy. He hollered for help and when he did not see any response he cried. After he stopped crying he stood there and thought. The tide would soon come up, so he began to gather rocks and pile them up one at a time. He made steps so that as the tide came up he would be able to climb to the top of the pile and stay above the water. This he did.

All of a sudden he heard a strange noised coming from above him. It was a commotion made by the noise of wings. When he looked up he saw a large eagle descending on him with its claws extended and ready to pick him up. He could not believe it when his feet left the ground but he did not put up any resistance.

The eagle finally let him down gently in front of what was to be his eagle family home. One of the eagles noticed this strange creature on their premises so right away he opened the door and asked very loudly "what is this human being doing in our yard?" He overheard the conversation in Tlingit. The eagle said to his father, "this is a human being I saved from drowning out on one of the reefs out there. The tide was overtaking him, do not harm him. Let me say that again, ***do not harm him!****" He stayed in the eagle community for years. He was well provided for with food, it was like living at home.*

From all appearances the eagle that saved the boy looked like an attractive young woman. Finally she spoke to her father saying, "he is my future husband, I want you to know this." This future wife of his talked with him at great length and gave him much advice. She asked him, "do you see the shirts that are hung on the wall? They all have power…but in varied degrees." She pointed to the sixth shirt and said, "that is the best one. It is the one with the most power…and it is called Ka.aan galshaat. My father is going to give you a gift. If he gives you a choice, make sure and choose Ka.aan galshaat." This is literally translated to mean lifting a whole town. Then she went on to say this is why, when an eagle gets its talons into its prey…it stays.

One day not long after, her father said, "I want to give you a gift." He showed him the shirts on the wall and said "yo are to choose on of the shirts that you see on the wall." The boy did not waste any time saying, "I will take that sixth shirt." Then the wise eagle father said, "that shirt is Ka.aan galshaat. The fourth and the third shirts do not have that much power but it is good for you not to have too much power at the very beginning. You would make a mess of it if you had too much power to work with before you had any experience. That is why I will give you the

third shirt; you will be able to see with keen mind and eye, your prey approaching the surface of the water. This will be give to you first of all. The eagle kwáan will bestow fortune upon you through my daughter. I want you to try out this third shirt and see what you can do."

He put the shirt on and went up on top of a high tree. He could see many, many things as clear as could be. He saw a fish come to the surface so he went out. His father-in-law told him, "now you just do not fly any old way, you fly the way the sun rises and sets, east to west. Do not forget this." So he picked his prey up, which was a black bass.

The second day he repeated the same ordeal of going up in the tree and looking around. When he saw an object coming to the surface he was all prepared for it, he had it timed so that just when he got to it, it was coming to the surface so he picked it up and brought it home. There he put it in front of his future father-in-law. It was a red snapper. The third day he went out and got a gray cod and brought it home.

The following day he went out and saw a hair seal and got his talons on it and this particular time the seal got away. So he went home and told his tale of woe about hosing his kill. He said I lost it because I was not strong enough. So his father-in-law gave him the fourth shirt.

He went out and caught the same seal and there was nothing to it. He caught a porpoise the following day and towed it ashore. He came across the same problem though later on when he lost a sea lion because he could not hang on to it. So his father-in-law gave him the final shirt and also a lecture about what a valuable shirt it had been for the many, many years it had been handed down. It had been handed down from generation to generation and people had become wealthy as a result of these shirts. "No doubt if you are obedient and ambitious and work hard you will be able to become one of the wealthy people. Now I have one word of caution. Try and keep greed out o this. Do not overkill. Kill only one at a time."

So he went out and made his first kill which was a sea lion. He towed it ashore. He caught many things and became a wealthy man and just before he retired, he though to himself, "well, I will go out for the last time." He caught a whale and looked around and saw another one very close by. He decided to kill that one also. He closed the two holes where it breathes on top and by doing that he was able to get the air in there and get them to float. During the night he towed them both ashore, just barely making it. He was about to make the last stroke when the raven crowed and the young man died.

- Questions to Consider as a class:
  - Traditional Tlingit stories were told young people to teach important lessons. What is the main theme of this story?
  - Can you think of potential examples of "whales" being taken today and the possible consequences?
  - Is the eagles' advice concerning use of resources being followed in Juneau? Can you think of examples of good stewardship of the living environment.
- Use the above consideration questions to expand student understanding of the concept of <u>enough</u> from the Tlingit story. Stress that there are two conflicting views of resources in the world today. One view is that <u>more is always better</u>. Individuals and groups who follow this philosophy have a goal of accumulation at any cost. They seek fulfillment and happiness in the accumulation of wealth (things).

- The other view, consistent with the traditional Tlingit story, is that one should strive to be a good steward of the land and living environment, striving to accumulate enough but no more. This view presents human fulfillment as deriving from harmonious behavior and positive relationships rather than the accumulation of wealth.
- Studies have shown that in American society, the "wealth and wellbeing threshold" for an individual is about $80,000 per year. Beyond that level of wealth, there is no increase happiness, social adjustment, or well being based on increased income.
- Read out loud by shared reading from the student packet, Alive in the Eddy as told by A.P. Johnson, to the class.
- Ask students to identify the behaviors and attitudes presented in the story. As students identify the attitudes and behaviors, list them on the board.
- Students should respond in their science journals to the prompt:
    - Is the message as relevant to us as it was to the historical Tlingit?

Step 2) Assessing Background Knowledge

- Read aloud *Alive in the Eddy* in the student packet. Discuss as a class:
    - How does this story relate to our attitudes and behaviors today?

Step 3) Building Background Knowledge

The Ecological Uniqueness of Southeast Alaska

- Display a map of Southeast Alaska in front of the students. (A printed map is available in the Salmon in the Trees Unit kit.) Begin by telling the students that the Tlingit believed that Southeast Alaska, the region where we are living, was a unique and special place. At the Coastal Temperate Rainforest Symposium held in Juneau in 2012, one of the scientists described this region as one of the most unique places on earth.
- Ask the students to brainstorm the evidence, facts, observations, and (human) activities which would support this statement.
- List the student contributions on the board for all to see as follows.

Southeast Alaska—one of the most unique places on earth

Evidence Facts Observations Activities

- To the student list, you may also add several of the following:
    - *The Tongass National Forest of Southeast Alaska includes almost 17 million acres. It is three times larger than any other national forest.*
    - *The Tongass includes the largest tracts of rain forest outside of the tropics.*
    - *The forest of SE Alaska contains nearly 1/3 of the old-growth (huge) trees in the world.*
    - *There are over 2,000 salmon producing streams in Southeast.*
    - *Southeast Alaska is a land of extremes: big trees, big fish, big birds, big bears, mountain goats, wolves, immense mountains, glaciers, whales and 11,000 miles of shoreline.*
    - *Southeast Alaska is one of the few areas in the world where the natural biological diversity is still intact and relatively healthy.*
- Allow time for sharing and discussion of the uniqueness of Southeast Alaska.

- Next, ask your students, “What is the science of Ecology?” Compare their responses with the scientific definition:
    - Ecology is the scientific study of interactions among organisms and between organisms and their physical environment.
- Have students write this definition on their Vocabulary Sheet. Additional questions for discussion:
    - Is there evidence of ecological knowledge in the Tlingit Story?
    - How (in what ways) do you interact with the environment?
- From these two activities, you can probe the level of awareness and experience your students have with the rainforest of Southeast Alaska.
- End this activity by sharing the following with your students:
    - The Tlingit who originally inhabited this land possessed a high degree of ecological knowledge.

- In the following (chapter extension) activities you will examine the place that we live, the Southeast rainforest, from two cultural perspectives, Western science and traditional Tlingit knowledge.

- Additional Information: The Tlingit language is one of the most complex and difficult languages to learn. The language includes 24 sounds not found in English and 4 sounds found in no other language on earth. Tlingit is a visual language, rich with metaphors based on the natural world. The language embodies a way of relating to the environment and respect for all living things. This cultural knowledge base, embodied in the grammar, metaphors, and oral narratives in the Tlingit language, developed over thousands of years. Several of the Tlingit historical narratives actually describe events which took place at the end of the last ice age!

Lesson 2
Xa'at Atwi Weo Aaslwamo: Salmon in the Trees

Purpose
To introduce and elaborate upon ecological concepts and definitions through place-based knowledge; to describe the role of salmon in maintaining forest health; to describe the relationship between streams and forest cover; to create a visual diagram of a Southeast Alaska's terrestrial food web.

Essential Questions
- How and why do organisms interact with their environment and what are the effects of these interactions?

Duration
2-3 (75-minute sessions)

Academic Vocabulary
- biosphere, biomass, consumer, ecology, food chain, food web, producer

Materials & Preparation
- Student composition notebooks
- Video: Salmon in the Tree (longer version 9:55 minutes, short version 2:57 minutes)
- Book: Salmon in the Trees by Amy Gulick (recommended resource)
- Large map of SE Alaska
- poster board, newsprint, or rolled paper
- Student page: Pre-assessment
- Student page: Learning extension #2

Suggested Guests
- A Tlingit elder or specialist to tell the students *Salmon Boy*

Literacy Strategies
- Close reading, visualization

Assessments
- Pre-assessment
- Journal prompt
- Class discussions

Procedure
Step 1) Introducing Content
- Pass out Salmon In The Trees Pre-Assessment Questions, Learning Extension #2 worksheet. Direct students to answer the three questions on the worksheet based on their present knowledge and level of understanding of the role of salmon in the Southeast forest ecosystem. Allow about ten minutes for this activity.

- When students have completed the activity, discuss the questions and share answers in the class. This will allow you to generally assess the level of student knowledge and to focus attention on the subject of the learning extension.

Step 2) Assessing Background Knowledge

Engage:

- Introduce Amy Gulick's book, Salmon in the Trees, to the class. Using this book and other pictorial resources, show several pictures of Southeast Alaska.
- Ask the students to do a five minute fast write about the topic:
  - What is special about Southeast Alaska to me?
- At the end of the five minutes, ask for volunteers to share what they have written.

Step 3) Building Background Knowledge

Explore:

- Display the map of Southeast Alaska. (see materials kit) Inform students that:
  A. they are going to learn about and explore several of the features which make Southeast Alaska unique, and
  B. Southeast Alaska, a region roughly 100 miles wide and 350 miles long, is the home of the largest temperate rainforest on earth. The Tongass National Forest, is the largest National Forest in the United States.
- Explain that the forest is the most obvious life form in the Tongass. The forest is actually a complex web of living things both animals and plants, which are interdependent in a complex balance of life. Local Tlingit, Haida and Tsimshian peoples have enjoyed the abundance of the Southeast forest ecosystem for ages. They possessed a sophisticated understanding of the balance of life in the rainforest. One of the mysteries that the indigenous people of this region understood was the role of the salmon in maintaining the health of the rainforest. This is knowledge which Western Science has only begun to comprehend in the last few decades.
- Now show the long version (about 10 minutes) of **Salmon in the Trees** from the CD in the materials kit.
- Immediately after viewing, ask the students to open their Science Notebooks and write for five minutes. summarizing what they have learned from the video. Then discuss in class.
  - Points to bring out: Salmon nurture the trees, even those hundreds of yards from the streams. (Animals move the dead salmon away from the trees. Mammals and birds which feed on the salmon leave droppings all over the forest which nurture forest growth.)
  - The trees protect the streams. Forest tree cover is essential to maintain optimal stream temperature for salmon eggs to grow. This relationship was not well understood by biologists or loggers until very recently. As late as the 1980's, clear cutting next to streams was legal and widely practiced in Southeast Alaska.
- Emphasize that the annual influx of salmon to the 2,000 plus streams of Southeast is essential part for the health of the rainforest. (Birds, bears, and other animals feed on the fish carcasses, eggs, and fry. They spread parts of the carcasses around and their scat is spread throughout the forest. Salmon are involved in nutrient transfer to the forest: Fish, Carbon, Nitrogen, Phosphorus, Forest (Thus, Salomon are in the trees.) This may lead to a lively discussion about the importance of the salmon runs and the potential effects of over fishing and clear cut logging.

Assess:

- Extend the learning with discussion:
  - Where do humans fit into this food web in Southeast and in Juneau?
  - How much of our food is from local sources? (This varies from family to family. In 2011, the University of Alaska estimated that 95% of all food consumed in Alaska is imported from the lower 48 and foreign countries.)
  - How does this compare with the Tlingit, who lived for thousands of years on this land?
  - Is there a movement in Juneau towards more localized food harvesting.
- The Tlingit refer to the ability to live off the land as food sovereignty. It is said that when one loses a taste for the local foods, one falls out of touch with the land and looses an essential part of really experiencing the place where one lives. Ask students to comment about this observation. People who are close to the land still say, "When the tide goes out, the table is set." What does that mean to you?
- Ask each group to brainstorm this question and come up with a group consensus:
  - Where should people fit into this Southeast Alaska food web?
  - Are we irrelevant, uninvolved, except for commercial fishing, getting our food supplies from the supply barge?
  - How should we be involved with the food web?
  - What can we learn from the past to help us with our place in the rainforest?

Additional Suggestion:

- Take students on a walking field trip to a salmon stream.
- What observations can students make?
- What evidence of human impact are seen?
- What other plant species do they see? What might be the human role in the health of this stream?

Homework:

- Students should complete the template in the student pocket identifying key primary producers, herbivores, carnivore, omnivores, scavengers, and decomposers.

Lesson 3
Five Species of Alaska Salmon

Purpose
To introduce and identify the five species of Pacific salmon; to differentiate between the behavioral (feeding and spawning) characteristics of various species; to understand the potential harmful effects of invasive salmon species.

Essential Question
-

Duration
1-2 (75-minute sessions)

Academic Vocabulary
- Dorsal fin, adipose fin, caudal fin, pectoral fin, operculum

Materials & Preparation
- Student composition notebooks
- Angler's Guide to Salmon Fishing in Alaska
- Game Fishes of Alaska
- Student page: Salmon Identification Notesheet

Suggested Guests
- A Tlingit elder or specialist to tell the students *Salmon Boy*

Literacy Strategies
- Close reading, visualization

Assessments
- Journal prompt
- Class discussions
- Group presentations

Procedure
Step 1) Introducing Content
Engage:
- Using a visual representation such as the Game Fishes of Alaska poster or another visual representation of Alaska fish, ask students to name as many game fishes which are native to Alaskan waters.
- Students will identify salmon, trout, halibut, and several other game fish. As students are naming fish species, tell them that the ability to accurately identify the five species of salmon is a basic Southeast Alaska skill. Tell students that they will be learning to identify the five native resident salmon species and one potentially troublesome invasive species.
    - Points to note:
      1. The word "species" is both singular and plural and refers to a biological classification of animals. (The word specie refers to money.)

2. Atlantic salmon are farmed in British Columbia. Escapements present a potential threat to wild salmon stocks in Alaska.
3. Introduce the Vocabulary terms which will help with salmon identification. Have students write the definitions on their Vocabulary sheet found in their student packet.

Step 2) Assessing Background Knowledge

Explore and Explain:

- Divide the class into six groups. Assign each group the task of researching, organizing and presenting one of the six salmon species in this extension activity (i.e. the five Alaska salmon and the one invasive species). The time you allot to this activity may vary depending on how extensive you want the presentation to be. If you have time, ask each group to make a (colored pencil and posterboard) an illustrated drawing of the species for the presentation. Each group presentation should include:
    - An introduction to the particular species (important facts, distribution, distinguishing behaviors, environmental concerns, health of species)
    - Significant identification features of the salmon species
- All students should be taking notes on the Salmon Identification Notesheet during the presentations. Allow time for questions and discussion after each presentation. There are several good web sites which include information about each species and identification features. (www.salmonnation.com is especially informative.)

Step 3) Building Background Knowledge

- Present pictures of various salmon species (from posters or project from internet) and have students practice identifying the species. Give students copies of the Invasive Atlantic Salmon card.

Lesson 4
Salmon in the Trees Project

Purpose
To combine previous knowledge into preparation for culminating activity; to assess student understanding and ability to communicate knowledge; to increase listening, reading, and writing fluency.

Essential Question
- What are the connections between people, plants, other animals, and the physical universe? (adapted from Inupiaq Learning Framework-Environment)

Duration
3-4 (75-minute sessions)

Materials
- Student page: Free response

Literacy Strategies
- Chunking the activity, close reading, questioning the text

Assessments
- Post-assessment journal prompt
- Final project presentation

Procedure
Step 1) Introducing Content
- Students can explore the marine coastal ecosystems in Alaska by conducting individual or small group investigations of issues related to the health of migratory fish. There is a host of potential questions and topics which can be selected for investigation.
- Among these are the following:
    - What has happened to the Yukon Kings?
    - Potential causes for the diminished runs in the Kuskokwim
    - What happened to the Auke Bay herring?
    - Is the current Southeast herring fishery sustainable?
    - Native fishing rights in Alaska
    - Effects of global warming on salmon maturation
    - The International Pacific Halibut Commission
    - Approval of gene modified salmon
    - Atlantic salmon as an invasive specie
    - Salmon farming vs wild caught salmon
    - How to know if salmon is farmed or caught
    - Forestry practices which protect salmon streams

Step 2) Assessing Background Knowledge
- Individual Project Option: Students can select and research a topic. Each student will write a 2 to 3 page factual report about the topic and present their findings to the class.

- Group Project Option: Groups of from 3 to 4 students select a topic related to the health and sustainability of salmon runs in Alaska, research the topic, produce a graphic summary of their findings, and present their findings to the class.

Step 3) Building Background Knowledge

- Allow time questions and group discussion after each presentation. Have students take notes in their science journal during each presentation.
- To evaluate this activity, have students write a one page free response (template in student packet) summary of the most significant insights or new information they have gained from the presentations.

Xa'at Atwu Wei Aaskwani: Salmon in the Trees

A Science Literacy Unit for High School: Student Packet

Photo Credit: 2013 GHF Path to Excellence Academy

Unit Overview: The Learning Extensions approach Ecology from two cultural perspectives—Western scientific biological knowledge and traditional Tlingit knowledge of the natural world. The activities are designed to lead students to better understand and appreciate the fragile balance of life which makes up the ecosystem of Southeast Alaska.

The extension activities reflect the Tlingit belief that a sense of place is the foundation of culture and wellbeing. Knowledge about place, and respect for place are both necessary for a person to live a healthy, well balanced life. Based on these cultural beliefs, these materials have been developed by the Goldbelt Heritage Foundation for all students in the Juneau schools to use and enjoy.

Standards Addressed in this Unit

Next Generation Science Standards & Alaska Standards for Culturally-Responsive Schools

NGSS Performance Expectations

HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem

LS2.B. Cycles of Matter and Energy Transfer in Ecosystems

Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)

HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

LS2.A: Interdependent Relationships in Ecosystems

Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1),(HS-LS2-2)

Cultural Standards for Students

A.7. Determine the place of their cultural community in the regional, state, national, and international political and economic systems

B.3. Make appropriate choices regarding the long0term consequences of their actions

D.1. Acquire in-depth cultural knowledge through active participation and meaningful interaction with Elders

E.2. Understand the ecology and geography of the bioregion they inhabit

Cultural Standards for Educators

A.1. Utilize Elders' expertise in multiple ways in their teaching

A.3. Provide opportunities for students to learn through observation and hands-on demonstration of cultural knowledge and skills

B.1. Regularly engage students in appropriate projects and experiential learning activities in the surround environment

D.3. Seek to continually learn about and build upon the cultural knowledge that students bring with them from their homes and community

Overview of Lesoons	Literacy Strategies	Academic Vocabulary	Assessments
Lesson 1: Alive in the Eddy Students will read together the Tlingit oral narrative, the Salmon Boy Story and examine the narrative for ecological insights. Using a display map of SE Alaska, sutdents will collectively share their thoughts about the meaning of the story and the ecological uniqueness of SE Alaksa.	• Close reading • Visualization	• ecology • ecological niche • biosphere	• Journal prompt • Class discussions
Lesson 2: Salmon in the Trees Using Amy Gulick's book, Salmon in the Trees and the 10 minute video with the same title, students explore the complex relationship that exists between salmon and the rainforest. Students write about the uniqueness of the temperate rainforest and construct a southeast forest food web.	• Quick write • Reread • Activating prior knowledge	• biomass • food chain • food web • producer • consumer	• Pre-assessment • Journal prompt • Class discussions
Lesson 3: Five Species of Alaska Salmon To introduce students to concepts of plant systems including plant structure and function, photosynthesis, and reproduction with a concluding ecological survey of a local area.	• Quick write • Graphic organizer • Activating prior knowledge • Chunking the activity	• dorsal fin • adipose fin • caudal fin • pectoral fin • operculum	• Journal prompt • Salmon ID notes • Class discussions • Group presentations
Lesson 4: Salmon Project Students will learn to identify the five species of Pacific salmon and the potentially invasive Atlantic salmon. Students will learn about the unique characteristics of the various Pacific salmon species and investigate environmental, commercial, and social issues which affect the health and sustainability of salmon runs in Southeast and throughout Alaska.	• Peer reflections • Close reading • Generating questions • Summarizing	• respect • woocheen	• Post-assessment prompt • Final presentation

ALIVE IN THE EDDY: AS TOLD BY A.P. JOHNSON

The story I am going to tell you belonged to the Kiks.ádi clan. The event took place near Sitka at the Nakwasena River.

Toward fall time we go to Nakwasena and we dry salmon. At first we dry the humpies. But we don't dry very many humpies. It doesn't keep very well for the winter. We only dry a few of them—maybe 25 or 50 of them per family. We eat it right away. We don't keep it for the coming winter.

Then comes the fresh run of the dog salmon, right from the ocean. We do not dry very many of them; we only dry a few. The eggs from the female dog salmon are still in one piece and the **milt** from the male is still hard and all in one piece when they first come in.

Now that dried salmon, that dried dog salmon is only kept for soaking. They are fresh run salmon from the ocean. When it's dried, it dries like a piece of wood. You couldn't even bite it. You couldn't take a bite off of it, even if you broiled it. They use it for soaking. They soak it down at the beach, maybe for 12 hours. By that time it's soaked enough and they boil it for breakfast. With seal oil it tastes good, especially to those who have grown up eating such food. They enjoy it very much; I know I do.

When the dorsal fin on the dog salmon begins to show white spots on top, on the end, they would take these dog salmon. The male dog salmon milt would be so soft it would start running. When it breaks open it almost runs out of it. And the female dog salmon eggs are very loose. If you just squeeze the stomach, eggs begin to fall out. Now quite a lot of these are dried for the coming winter. And when you broil it over the fire the flesh is crumbly, nice and soft. Even the old people enjoy it, even though they haven't got very strong teeth. It's very delicious. It doesn't contain very much oil. It's mostly fish flesh and not much oil.

And this is what they were doing in Nakwasena. People were there to put up food. They were already putting up the winter supply of dog salmon, drying it up thoroughly. And the boys were having lots of fun on the beach.

We are taught to capture birds and animals alive. But we do not keep them as pets. The moment we catch them we let them go. Sometimes we use snares. Aak'wtaatseen, a young boy of 12 or 14, was playing with a snare his father made him near the shore of the river.

Now, a lot of loose salmon eggs are put in the bottom of the river under the snare. And the seagulls have a habit of dipping down. As they dip down to eat the salmon eggs they'll put their head through the snare. When they come back up it's around their neck.

We'd have lots of fun. We'd go down there. Our mothers would put dry clothes on us. In less than 5 minutes we are soaking wet from head to feet. Even the shoes are all soaking wet.

And that's what Aak'wtaatseen was doing, and they were having lots of fun, counting how many seagulls they had caught. In the midst of all that, Aak'wtaatseen had gone home to eat his noon

lunch. He was very hungry. He knew what to do. He ran on up to the house where his mother was preparing the winter supply of food.

He asked his mother, “Mother, may I have a piece of dried fish?” His mother gave him a piece. “Here, you eat that.” It’s somewhat rich; the part of the salmon she gave him is somewhat rich.

He looked at it. “Ahh, the salmon is a little moldy.” He complained. “It’s a little moldy.”

His mother told him, “A little mold won’t hurt you. Go ahead and eat it.”

Just them someone called out form the beach. “Aak’wtaatseen! You have a seagull in your snare!”

He forgot about the piece of dried salmon and started to run. When he went out in the water, the seagull began to pull the whole thing out. It came loose from the rocks and kept on going and pretty soon the water was up above his waistline. He disappeared.

The father ran down, got in the water. The water was clear. There was no sign of Aak’wtaatseen. There were just dog salmon swimming around. No one knew what happened to Aak’wtaatseen.

According to the story, the people of the salmon captured him. The salmon people took him way out to the ocean, way out on the sea; took him to the place where the young salmon go in the fall of the year after they leave the salmon river. He stayed out there for about three or four years among the salmon people.

There was a time he was so very lonesome, he could not even bear it. He felt like weeping. But he decided he wasn’t going to weep. He rebelled. He didn’t want to eat anything. They tried to give him food but he wouldn't take it. They took him to the mouth of a large river. On each side of the river, just as it enters the ocean, there was a creature in the water. One on his side, another one on his other side.

They were the happiest creatures. All day long they danced. They’d go up and down in the water and come up again, and then would go down again. Aak’wtaatseen hadn’t laughed now for many days. They took him to one side of the river and put his arms around one of the creatures. They told him, “Now, you hang on tight, don’t be afraid of getting drowned.” As he put his arms around the creature, the creature began to dance with him. It amused him so much he started laughing. And they put his arms around the other one. After that he was himself again.

Now one day they told him, “We’re going to go to a big diner that’s going on. It’s put on by different people. The people are people whom you know. You are well acquainted with them, but you have never thought of them as people. You thought of them as creatures of the sea.”

As he came near the place with the salmon people, he heard people singing Indian songs that were very happy, and beating a drum. You could see feathers flying all over. The feather, the symbol of peace. He wanted to see who they were. He looked through a crack, and as he looked through the crack he felt something on his face. It seemed to be covering that part of his face

where he thought the feathers were flying around. When he reached up and scratched it he found on him herring eggs. Those were herring people putting on a big dance.

After Aak'wtaatseen left he went back and one day they told him, "We are going back to your country, to the place that you came from." They kept on going. Everybody was paddling. He wasn't paddling; he was sitting right in the middle of the canoe, and each time they would tell him where they were.

According to the Tlingit people, way out in the ocean, in the middle of the ocean in the deep places, there is no light. It's all dark. And when they came to the line where it gets dark, Aak'wtaatseen saw very fearful things ahead of him. There were large eyes looking at him. And each time before an individual went past the line he would let out a war cry and he'd rush right by those places in a hurry. As they went by, some of them were bitten. And when the salmon come to the river you find teeth marks on some of them. You never knew what bit them, what kind of creature bit them.

At this time we already had copper; we were using copper for implements and ornaments. There were those who worked in metal who would make copper wires. They made it into the form of a rope. Very flexible. More like chains all linked together. They would measure a full-grown man's neck, and when the child got to be a certain age, when the head was the size of a grown man's neck, they would slip this endless copper rope over his head. And the child commenced to grow, and they wouldn't take this off; he died with it on. And this showed the person was from an aristocratic family and they put this around the neck of Aak'wtaatseen when he was a baby, being of an aristocratic family.

And when he came nearer the river, the father and the mother saw a very nice looking, streamlined dog salmon. It was so pretty, a very large dog salmon, unusually larger than the rest, with no marks on it. It was a perfect fish.

Aak'wtaatseen recognized his family before he went on up the river. As they came to where the river people were going, some of his friends, some relatives, were going in a canoe. The fish people told Aak'wtaatseen, "There is your clan going up there. They know who you are. Stand up and look at them." Aak'wtaatseen in his mind stood up. He thought he stood up. Instead of that, the people in the canoe called out, "Here jump!"

Finally the father hooked him, brought him ashore and the mother started to cut the head, and they found under the skin was this copper rope. She recognized him.

Then all the women cleared out and cleansed the whole smoke house. They put him on the platform right above the door. They had no fire in it. They put the body of the fish there and they put a very nice skin blanket over it. For several days it was there.

And finally, they heard the blue fly's sound up there. And it began to change into a tune. The platform was very large. Big enough to hold a human being. As time went on they knew it wasn't a

blue fly, but a person singing. And they went up there on a ladder and took his body down. He returned back with his own people.

And it was told that he became one of the strongest ix̲t' of the Kiks.ádi people. He practiced telepathy and portation. He could communicate with Kake from here. That was the first wireless station in Alaska.

When they brought him down he became one of the strongest ix̲t' among the Kiks.ádis. And later on he composed a song. It did not become the national song but we sing it quite often. You don't dance to this song, like you would any other. You have mountain sheep wool dyed red. The women wear them hanging from their ears. The first verse you swing towards your left. The second verse you swing to the right. And the men keep time with the long sticks with the emblems on them.

SOUTHEAST ALASKA:

ONE OF THE MOST UNIQUE PLACES ON EARTH

Evidence	Facts	Observations	Activities

NAME: _____ DATE: _____

SALMON IN THE TREES: PRE-ASSESSMENT (LESSON #1)

1. Write a paragraph which describes three to five important facts about salmon in Southeast Alaska.

2. Describe the relationship between salmon and the forests of Southeast Alaska?

IDENTIFYING THE FOOD WEB

Primary Producers					
Herbivores					
Carnivores					
Omnivores					
Scavengers					
Decomposers					

VOCABULARY

Write the scientific definition for each of these words.

biosphere

biomass

consumer

producer

ecology

food chain

food web

ecological niche

food sovereignty

ecological footprint

dorsal fin

andipose fin

caudal fin

operculum

SALMON IDENTIFICATION NOTESHEET

Directions: Use this sheet to take notes from the Salmon Identification presentations. Write down the significant identification characteristics of each salmon species.

King (Chinook)

_____

_____

_____

_____

_____

Coho (Silver)

_____

_____

_____

_____

_____

Pink (Humpback)

_____

_____

Sockeye (Red)

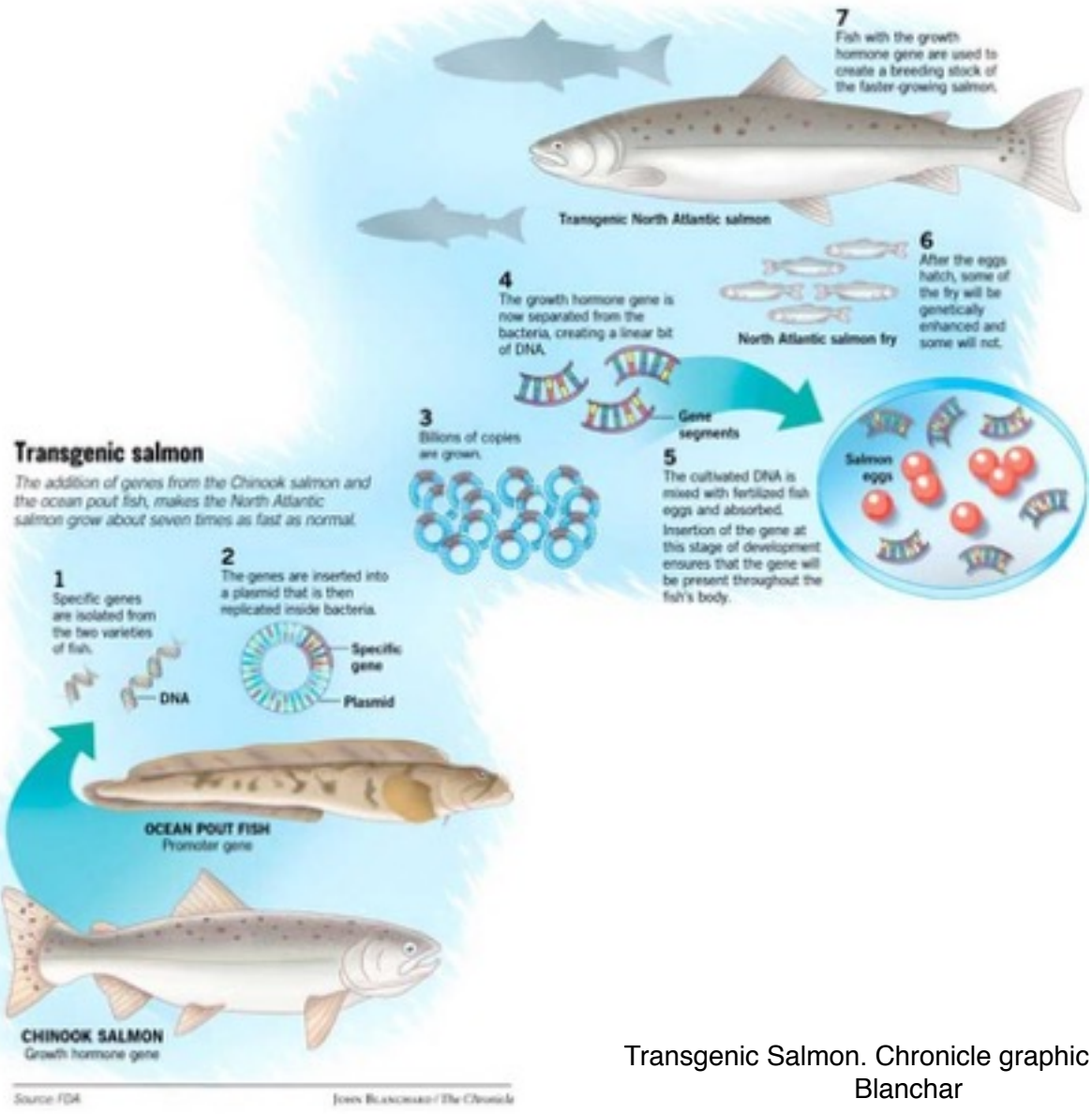
Chum (Dog)

Name: _____ Date: _____

FREE RESPONSE

Read the following article, and respond with a defensive statement supporting or opposing the introduction of genetically engineered fish into local Alaskan waters.
Article originally found: http://www.sfgate.com/news/article/Frankenfish-spawn-controversy-Debate-over-2843540.php

'Frankenfish' spawn controversy: Debate over genetically altered salmon
Jane Kay, Chronicle Environment Writer Published 4:00 am, Monday, April 29, 2002



Transgenic Salmon. Chronicle graphic by John Blanchar

It looks like a North Atlantic salmon. But it grows seven times faster, and it's much more attractive to the opposite sex than a normal salmon.

It's a transgenic fish, the first genetically engineered animal under review for the U.S. food supply. Embedded in every cell of its body are genes from the Chinook salmon and the ocean pout fish that make it grow more quickly.

The altered salmon is likely to become the next focus in the battle over bioengineered food, after controversies over the desirability of genetically altered bovine growth hormones in cows and modified corn, soybeans and canola in cereals and tortilla chips.

In the next year, the U.S. Food and Drug Administration will consider a petition by Aqua Bounty Farms of Waltham, Mass., to farm and market the altered salmon.

Already, the prospect of mutant fish escaping and disrupting already threatened wild populations has prompted lawmakers in several states to take pre-emptive steps. California could become the first state to ban transgenic fish outright.

Last week, the Senate Natural Resources Committee approved a bill by Sen. Byron Sher, D-Palo Alto, that would make it illegal to import, transport, possess or release transgenic fish. They would be considered an "aquatic nuisance," a category that includes piranhas, slugs and giant toads that threaten wildlife.

Another bill by Assemblywoman Virginia Strom-Martin, D-Duncan Mills, would require labeling of transgenic fish sold in markets. And a joint legislative resolution introduced by Assemblyman Joe Nation, D-San Rafael, urges the FDA to deny Aqua Bounty's petition and put in place a moratorium on transgenic fish.

'FRANKENFISH' CONDEMNED

The bills -- and Sher's in particular -- have strong support from consumer, environmental and commercial fishing groups, which dub the altered salmon a "Frankenfish" that would eat or outcompete smaller wild species and cause their extinction. What's more, critics say, federal regulatory oversight of bio-engineered foods is not sufficient to guarantee the fish are safe to eat.

Proponents of biotechnology, on the other hand, view transgenic fish as the answer to supplying consumers with healthful fish without depleting the ocean's declining populations. To fish farmers, it means being able to grow salmon in half the time and at lower feed costs.

Sher's bill could abruptly end these hopes. Biotechnology trade groups, the National Food Processors Association, the state Chamber of Commerce, California Farm Bureau and the California Grocers Association oppose the legislation.

Passing a strict anti-transgenic fish state law would create "a precedent, and could poison the well. Once the door is shut, we may never be able to find the key to open it up again," said George Gough, a Sacramento lobbyist for Monsanto Co.

He urges legislators to leave it up to the FDA, which must consult with federal wildlife and fisheries agencies, to decide whether the bio-engineered salmon is safe.

"This is really the first biotech animal that is going through the review process. The FDA is going to be taking a microscope to this, and it should. When you you say 'fish' or 'beef,' it hits you more than when you say 'soybean, ' " he said.

While Monsanto doesn't work with fish, it's one of the largest producers of transgenic crops, holding dozens of patents on new biotech products, among them soybeans, potatoes, canola and corn. The company believes a California ban would have a chilling effect on the industry and investors.

Opponents of biotechnology say a pre-emptive strike is crucial. About two dozen varieties of genetically engineered fish or shellfish are under development, most aimed at increasing growth and resistance to disease in such species as abalone, oysters, stripped bass, rainbow trout, catfish and tilapia.

THREAT TO NATURAL RESOURCES

"These genetically engineered fish will pose a threat to our natural resources," said Natasha Benjamin, program officer with the Institute for Fisheries Resources, a research arm of the Pacific Coast Federation of Fishermen's Associations.

"California is known to set a precedent when it comes to environmental standards. We hope to see the state take the lead in this issue, and hopefully other states will follow," she said.

At the crux of the debate is whether the superfish would escape into the wild and harm native salmon populations. Damaged by dams, pollution, invasive species and loss of fresh water, salmon are already struggling for sustainability on the Pacific Coast.

A 1999 study by Purdue University scientists predicted ecological risks from the release of transgenic fish into the wild.

The researchers found the larger transgenic fish were more attractive mates for native fish, thus allowing a trait to spread quickly through the wild population. But because the offspring don't live long, eventually the native population would be wiped out.

The study caused widespread concern because in aquaculture, the escape of farmed fish is inevitable.

TRANSGENIC FISH LAWS

Last year, Maryland passed a law prohibiting transgenic fish any place that might connect with waterways. In Oregon, the law prohibits the release of transgenic fish into locations where they can mingle with wild populations. There are discussions in Alaska over an outright ban.

Representatives of Aqua Bounty Farms say its modified Atlantic salmon won't threaten wild stocks. The company will use only sterile females in netted pens, so, if they escape, they won't spawn and pass along the genetic traits.

Joseph McGonigle, vice president of Aqua Bounty, said the technique that his company uses to sterilize eggs "is 100 percent effective. We will be doing . . . screening on every batch of eggs that is done."

But fish scientists, including some from the aquaculture industry, say there is still a chance that a small percentage of fish will be fertile. And they predict another problem: Wild male salmon will try to mate with the larger but sterile female salmon, depressing reproduction rates.

Aquaculture is the fastest growing segment of agriculture, according to the U.S. Department of Agriculture. In California, sales of farmed fish and shellfish have jumped from $33 million a year in 1991 to $71 million in 1999 from more than 100 producers.

"The majority of our producers are not involved in transgenics. What we're grappling with is that there may be some transgenic techniques that are proven safe that would be excluded by this bill," said Justin Malan, executive director of the California Aquaculture Association.

The trade group is negotiating with the bill's author to change the language. One of the aquaculture industry's problems is that the bill shuts out all commercial ventures.

"It's a question of whether the importation of transgenic fish should be banned or adequately regulated," Malan said. "We don't have a problem with stipulations that will safeguard the environment or public health, but a ban is forever."