Next Generation Science Standards—
Nimbus Hatchery Tour Correlations
Grade K

K-LS1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can: Use observations to describe patterns of what plants and animals (including humans) need to survive. [Clarification Statement: Examples of patterns could include that animals need to take in food but plants do not; the different kinds of food needed by different types of animals; the requirement of plants to have light; and, that all living things need water.]

Disciplinary Core Ideas: LS1.C: Organization for Matter and Energy Flow in Organisms

All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow.

Nimbus Correlation: As fry, salmon and steelhead eat zooplankton and insects. Adults eat other, smaller fish.

K-ESS2 Earth's Systems

Students who demonstrate understanding can: Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.

Disciplinary Core Ideas: ESS2.E: Biogeology

Plants and animals can change their environment.

Nimbus Correlation: Salmon move the gravel with their tails while digging a redd (nest).

ESS3.C: Human Impacts on Earth Systems

Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things.

Nimbus Correlation: By conserving water at home and at school and preventing pollution, we can help maintain healthy homes for salmon and other animals.

K-ESS3 Earth and Human Activity

Students who demonstrate understanding can: (1) Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live. (2) Communicate

solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

Disciplinary Core Ideas: ESS3.A: Natural Resources

Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do.

Nimbus Correlation: Humans built the dam so that we could store water to use in our homes and on our crops. We have to share the water with salmon and other wild animals that live there.

ESS3.C: Human Impacts on Earth Systems

Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things.

Nimbus Correlation: By conserving water at home and at school and preventing pollution, we can help maintain healthy homes for salmon and other animals.

Next Generation Science Standards—
Nimbus Hatchery Tour Correlations
1st Grade

1-LS1 From Molecules to Organisms: Structures and Processes

1-LS1-1 Students who demonstrate understanding can: Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs. [Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]

Disciplinary Core Idea: **LS1.A: Structure and Function**

All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow.

Nimbus Correlation: Salmon have fins to move from place to place, turn, balance, and maneuver. They have teeth on their tongues to help them grasp and hold on to prey. Salmon use their noses to smell and their gills to breath. The swim bladder acts like a balloon inside the fish, allowing it to float up or sink down in the water column. Later in life, male salmon develop hooked jaws and teeth to ward off male competition.

LS1.D Information Processing

Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive.

Nimbus Correlation: Salmon have a keen sense of smell that allows them to recognize the scent of the river in which they were born. They follow this scent trail back from the ocean to their home stream when they are ready to spawn.

1-LS1-2 Students who demonstrate understanding can: Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

Disciplinary Core Idea: LS1.B: Growth and Development of Organisms

Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive.

Nimbus Correlation: Female salmon select an ideal nesting ground in which to lay their eggs (fist-sized cobble, clean, cold water, sufficient flows to provide oxygen to the eggs), and they cover their eggs with more cobble to minimize predation. Fry swim among the roots of overhanging trees to avoid predators, and in the ocean, salmon swim in schools to reduce predation.

1-LS3-1 Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can: Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

Disciplinary Core Idea: **LS3.A: Inheritance of Traits**

Young animals are very much, but not exactly like, their parents. Plants also are very much, but not exactly, like their parents.

Nimbus Correlation: Like humans, salmon are a mixture of their mother and their father. They look and behave very similarly to their parents, but are not exactly the same.

LS3.B: Variation of Traits

Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.

Nimbus Correlation: Salmon may attain different weights, lengths and colorations.

Next Generation Science Standards—
Nimbus Hatchery Tour Correlations
Grade 2

Life Science

2-LS4 Biological Evolution: Unity and Diversity

Students who demonstrate understanding can: Make observations of plants and animals to compare the diversity of life in different habitats.

Disciplinary Core Ideas: LS4.D: Biodiversity and Humans

There are many different kinds of living things in any area, and they exist in different places on land and in water.

Nimbus Correlation: Many plants and animals share the river with the salmon and dwell along the riverbanks. Salmon are directly or indirectly connected to all these living things through the food web.

2-ESS1 Earth's Place in the Universe

Students who demonstrate understanding can: Make observations from media to construct an evidence-based account that Earth events can occur quickly or slowly. [Clarification Statement: Examples of events and timescales could include volcanic explosions and earthquakes, which happen quickly and erosion of rocks, which occurs slowly.]

Disciplinary Core Ideas: ESS1.C: The History of Planet Earth

Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe.

Nimbus Correlation: Floods can change the land very rapidly, while erosion causes impacts that are just as significant over long periods of time.

2-ESS2 Earth's Systems

Students who demonstrate understanding can: (1) Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land. (2) Develop a model to represent the shapes and kinds of land and bodies of water in an area. (3) Obtain information to identify where water is found on Earth and that it can be solid or liquid.

Disciplinary Core Ideas: ESS2.A: Earth Materials and Systems

Wind and water can change the shape of the land.

Nimbus Correlation: The flow of water has carved out the riverbed and continues to change its course over time.

ESS2.B: Plate Tectonics and Large-Scale System Interactions

Maps show where things are located. One can map the shapes and kinds of land and water in any area.

Nimbus Correlation: The map on the wall in the Visitor Center shows the watersheds encompassing our region, including rivers, lakes, reservoirs, the Delta, bays, and the ocean.

ESS2.C: The Roles of Water in Earth's Surface Processes

Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form.

Nimbus Correlation: Waterways are connected to one another, as shown on the map. This allows the passage of living creatures and other matter from one part of the region to another.

Next Generation Science Standards—
Nimbus Hatchery Tour Correlations
Grade 3

Life Science

3-LS1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can: Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

Disciplinary Core Ideas: LS1.B: Growth and Development of Organisms

Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles.

Nimbus Correlation: The salmon life cycle can be summarized as: egg->alevin->fry->smolt->adult->spawner. Each stage of the life cycle has characteristic features. All Pacific salmon die after they spawn.

3-LS2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can: Construct an argument that some animals form groups that help members survive.

Disciplinary Core Idea: LS2.C: Ecosystem Dynamics

When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.

Nimbus Correlation: Changes in the temperature, clarity, etc. of the river may make it harder for salmon to survive and allow invasive species to gain a foothold. Conversely, restoring habitat in the river (i.e., adding gravel and/ or woody debris, deepening channels), may improve salmon survival.

LS2.D: Social Interactions and Group Behavior

Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size

Nimbus Correlation: In the ocean, salmon swim in schools to minimize the dangers of predation. Each fall, salmon return to their natal rivers in a seasonally-timed "run" to spawn and die.

3-LS3 Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can: (1) Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. (2) Use evidence to support the explanation that traits can be influenced by the environment.

Disciplinary Core Ideas: LS3.A: Inheritance of Traits

Many characteristics of organisms are inherited from their parents.
Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment.

Nimbus Correlation: Salmon inherit their coloration, size limits, instinctual behaviors, and the timing of their spawning from their parents. Environmental conditions affect what and how much they consume, how large they grow, and how long they remain in the ocean, among other things.

LS3.B: Variation of Traits

Different organisms vary in how they look and function because they have different inherited information.
The environment also affects the traits that an organism develops.

Nimbus Correlation: Salmon are not all the same size or color, and some salmon are more effective predators and spawners than others.

3-LS4 Biological Evolution: Unity and Diversity

Students who demonstrate understanding can (1) Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago (2) Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing (3) Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. (4) Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change. [Clarification Statement: Examples of environmental changes could include changes in land characteristics, water distribution, temperature, food, and other organisms.] [Assessment Boundary: Assessment is limited to a single environmental change. Assessment does not include the greenhouse effect or climate change.]

Disciplinary Core Ideas: LS4.B: Natural Selection

Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing.

Nimbus Correlation: As salmon grow and develop their physical appearance changes (i.e. parr marks, silvery smolts, red spawning adults and male development of hooked jaws and humps). These physical changes, although similar among the population, are different among specific individuals and give each individual a different competitive edge that may or may not make them more "fit" than other salmon.

LS4.C: Adaptation

For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.

Nimbus Correlation: Salmon have adapted an anadromous lifestyle in which they migrate from the streams where they are born, to oceans and back to their natal stream. Salmon are adapted special traits to survive this arduous journey, for example stream-lined bodies to increase efficiency when swimming upstream.

LS4.D: Biodiversity and Humans

Populations live in a variety of habitats, and change in those habitats affects the organisms living there.

Nimbus Correlation: Adaptation is crucial to the success of all species, when faced with habitat change. Salmon in the American river will have to adapt to warmer water conditions and lower water levels.

Next Gen Science Standards—
Nimbus Hatchery Tour Correlations
Grade 4

Life Science

4-LS1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can: (1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. (2) Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.

Disciplinary Core Ideas: LS1.A: Structure and Function

Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

Nimbus Correlation: Anatomy of salmon—fins, teeth, teeth on tongue, gills, scales, slime, swim bladder, ovaries, etc.

LS1.D: Information Processing

Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions.

Nimbus Correlation: The lateral line helps a fish keep its balance and maintain awareness of surroundings; salmon have a tremendous sense of smell, which they use to locate their home river when returning from the ocean to spawn.

Earth Science

4-ESS2 Earth's Systems

Students who demonstrate understanding can: (1) Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. (2) Analyze and interpret data from maps to describe patterns of Earth's features.

Disciplinary Core Ideas: ESS2.A: Earth Materials and Systems

Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

Nimbus Correlation: The river is constantly changing due to erosion and flow velocity; humans cause erosion by cutting down embankments; cobble is washed away over time and has to be replaced manually since the dam blocks the downstream progress of new cobble.

ESS2.E: Biogeology

Living things affect the physical characteristics of their regions.

Nimbus Correlation: Female salmon stir up the cobble on the river floor to make their nests. Decomposing salmon add nutrients they have carried from the ocean to the river

4-ESS3 Earth and Human Activity

Students who demonstrate understanding can: (1) Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. (2) Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

Disciplinary Core Ideas: ESS3.A: Natural Resources

Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.

Nimbus Correlation: One purpose of the dams is to generate electricity. While hydroelectricity is renewable, the dams have negative effects on salmon by blocking access to spawning grounds and affecting water temperature, depth, and current flow.

ESS3.B: Natural Hazards

A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions, floods). Humans cannot eliminate the hazards but can take steps to reduce their impacts.

Nimbus Correlation: The primary function of Nimbus and Folsom dams is to limit the dangers of floods along the American River and to conserve water for dry periods and droughts.

Next Generation Science Standards—
Nimbus Hatchery Tour Correlations
Grade 5

5-LS2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can: Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. [Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.]

Disciplinary Core Ideas: LS2.A: Interdependent Relationships in Ecosystems

The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.

Nimbus Correlation: The prey species of salmon rely directly or indirectly on plant matter for their nutritional requirements. Young salmon eat insects, invertebrates and plankton; adults eat other fish, squid, eels, and shrimp. When salmon die, their bodies are decomposed and some materials are returned to the ecosystem where the nutrients are recycled. Shocks to the ecosystem, like competition from non-native species can destabilize the ecosystem's balance.

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

Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment.

Nimbus Correlation: Gills mediate the gas exchange in salmon. Water flows over their gills where dissolved oxygen is absorbed and carbon dioxide is expelled from the system. Minerals are absorbed through the gills, fins and skin of salmon.

5-ESS2 Earth's Systems

Students who demonstrate understanding can: (1) Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. [Clarification Statement: **The geosphere, hydrosphere (including ice), atmosphere, and biosphere are each a system and each**

system is a part of the whole Earth System. Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. (2) Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

Disciplinary Core Ideas: ESS2.A: Earth Materials and Systems

Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate.

Nimbus Correlation: Salmon belong to the biosphere and are most directly influenced by the hydrosphere, since they spend their lives in fresh and salt water systems. Local water systems, like their natal river, affect their lives most directly--for example, local or regional droughts. However, global systems, like the ocean, which influences Earth's climate, have long-lasting implications for salmon.

ESS2.C: The Roles of Water in Earth's Surface Processes

Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.

Nimbus Correlation: Although rivers represent only a small fraction of Earth's fresh water, their role in the salmon life cycle is crucial, as salmon spawn and hatch in river systems.

5-ESS3 Earth and Human Activity

Students who demonstrate understanding can: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Disciplinary Core Ideas: ESS3.C: Human Impacts on Earth Systems

Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.

Nimbus Correlation: Due to chemical fertilizer run-off from agriculture farms, too many nutrients, especially nitrogen, are entering the river systems. These excess nutrients wreak havoc on river system causing algae blooms which deplete oxygen levels in the water. This process, called eutrophication, affects salmon that rely on dissolved oxygen in the water to breathe.

Next Generation Science Standards—
Nimbus Hatchery Tour Correlations
Grade 6

MS-LS1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can: (1) Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. [Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds; and, creating conditions for seed germination and growth. (2) Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water.]

Disciplinary Core Ideas: LS1.A: Structure and Function: In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.

Nimbus Correlation: Salmon have many specialized body parts. The skin of salmon is covered in scales, which act as protection and helps to stream-line their bodies to swim faster. Gills allow salmon to absorb dissolved oxygen from the water. Swim bladders allow salmon to achieve neutral buoyancy in the water

LS1.B: Growth and Development of Organisms

Animals engage in characteristic behaviors that increase the odds of reproduction.

Nimbus Correlation: Adult salmon return to their natal stream for reproduction. Some salmon have to travel thousands of miles to the mouth of the stream they were born. It is a rigorous journey and only the 'fittest' salmon survive it to make it the spawning grounds and reproduce.

MS-LS3 Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can: Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

Disciplinary Core Ideas: LS1.B: Growth and Development of Organisms

Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring.

Nimbus Correlation: Male salmon arrive first to establish territories. Gravel beds are the best territories. A female will initiate spawning by digging a depression--called a redd--in the gravel. The male and female salmon will then release their gametes (eggs and sperm), into the red at the same time. Female salmon will release between 2,000-10,000 eggs. This process is an example of external fertilization.

LS1.D: Information Processing

Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories.

Nimbus Correlation: Recent research suggests that salmon use magnetic fields to orient themselves towards the ocean and to locate the mouth of their natal river when returning to spawn. Salmon also use olfactory (chemical) signals to locate their home waters. When attacked by a predator, salmon release a chemical cue from their skin that signals danger to other fish.

LS3.A: Inheritance of Traits

Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS3-2)

Nimbus Correlation: Salmon may differ in appearance and behavior from one another based on the combination of genetic information received from their parents.

LS3.B: Variation of Traits

In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.

Nimbus Correlation: Salmon may be very much like one or both parents, or a mixture of the two, depending on the genetic information they have inherited.

MS-ESS2 Earth's Systems

Students who demonstrate understanding can: Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. [Clarification Statement:

Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle.

Disciplinary Core Ideas: ESS2.C: The Roles of Water in Earth's Surface Processes

Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.

Variations in density due to variations in temperature and water salinity drive a global pattern of interconnected ocean currents.

Nimbus Correlation: The water cycle is critical to salmon successes; they rely heavily on healthy and reliable river systems for spawning. Ocean currents affect the travels of salmon during their adult years and also strongly influence the abundance of food available to salmon. This in turn influences when salmon ultimately leave the ocean and return to their natal rivers.

MS-ESS3 Earth and Human Activity

Students who demonstrate understanding can: (1) Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).] (2) Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

Disciplinary Core Ideas: ESS3.C: Human Impacts on Earth Systems

Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.

Nimbus Correlation: Salmon are impacted by global human activities, i.e. climate change, as well as and local human activities, i.e. habitat loss, through the development of our river systems. For example, the building of dams on most of our waterways have influenced the life cycle of salmon that now have an obstructed path up-river to spawn. Humans have tried to mitigate this with fish ladders, as seen at Nimbus Hatchery.

ESS3.D: Global Climate Change

Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities.

Nimbus Correlation: California's climate has been warming dramatically lately, causing noticeable drought conditions. Warmer air and less rainfall cause river temperatures to rise, including the American River. Warmer river water negatively affects salmon reproduction, whose eggs rely on a specific temperature, 55-60° F, to develop. Drought conditions also influence the survival rates of adult salmon.

Next Generation Science Standards—
Nimbus Hatchery Tour Correlations
Grade 7-8

(7) MS-LS2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can: (1) Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. (2) Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. [Clarification Statement: Examples of types of interactions could include competitive, predatory, and mutually beneficial.] (3) Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. (4)Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. (5) Evaluate competing design solutions for maintaining biodiversity and ecosystem services

Disciplinary Core Ideas: LS2.A: Interdependent Relationships in Ecosystems

Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.
In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.
Growth of organisms and population increases are limited by access to resources. Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.

Nimbus Correlation: In low water years, competition between salmon for suitable spawning habitat can result in redds being dug up or displaced and the eggs they contain lost. Fry are subject to higher predation rates when river levels drop and afford fewer hiding places. Fishing limits are imposed on commercial and recreational anglers to avoid depleting populations of fish in a given year or over the long term.

LS2.B: Cycle of Matter and Energy Transfer in Ecosystems

Food webs are models that demonstrate how matter and energy is transferred between producers~~,~~ consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.

Nimbus Correlation: Salmon are part of a complex food web throughout the stages of their lives, up to and including the recycling of the nutrients in their bodies by scavengers and decomposers. Some of these nutrients were acquired by the salmon in the ocean and would not be available to the river ecosystem if salmon were not present. Nutrients from decomposing salmon enrich the soil and allow aquatic and riparian plants to flourish. Aquatic insects which feed on salmon carcasses can in turn become food for the next generation of salmon fry.

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health.

Nimbus Correlation: A range of physical and environmental conditions affect the salmon population from year to year, and numbers can fluctuate dramatically without indicating real problems. However, large-scale changes to the physical environment caused by global warming, pollution, water diversions, invasive species, etc. are presenting real and significant challenges to the survival of salmon as a species.

LS4.D: Biodiversity and Humans

Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling.

Nimbus Correlation: A decline in the numbers of salmon in the ocean and returning to the rivers negatively affects commercial and recreational fishing.

(8) MS-LS3 Heredity: Inheritance and Variation of Traits

Students who demonstrate understanding can: Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

Disciplinary Core Ideas: LS3.B: Variation of Traits

In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism.

Nimbus Correlation: Salmon may differ in appearance and behavior from one another based on the combination of genetic information received from their parents.

MS-LS4 Biological Evolution: Unity and Diversity

Students who demonstrate understanding can: (1) Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. (2) Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.] (3) Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

Disciplinary Core Ideas: LS4.B: Natural Selection

Natural selection leads to the predominance of certain traits in a population, and the suppression of others.

In *artificial* selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring.

Nimbus Correlation: Those salmon best suited to survival in the unique conditions of their natal stream, as well as to the rigors of outward and return migration and ocean survival, have a higher likelihood of surviving to reproduce and pass on their genes, thereby increasing the occurrence of these successful traits in the population. At the hatchery, the conditions in which the salmon are reared may differ in significant ways from conditions in the river, which in turn affects the relative success of hatchery and naturally spawned salmon.

LS4.C: Adaptation

Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.

Nimbus Correlation: Generation after generation of salmon has returned to its natal stream to spawn, which has resulted in reproductively isolated spawning populations with specialized adaptations for their natal habitat. Changes to the Sacramento and American Rivers have impacted salmon and steelhead populations. Rearing salmon in hatcheries may also affect the distribution of traits in the population.

MS-ESS3 Earth and Human Activity

Students who demonstrate understanding can: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Disciplinary Core Ideas: ESS3.C: Human Impacts on Earth Systems

Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

Nimbus Correlation: Competition for water resources, pollution, loss of habitat to dams, siltation of rivers, and other adverse effects of human population growth and consumption increases have had negative effects on fish populations. Fishing closures, bag and possession limits, and gear restrictions are set in order to manage the take of fish by commercial and sport anglers. Regulation and management of development, agriculture, forestry, and other human activities also affects natural resources.

Next Generation Science Standards—
Nimbus Hatchery Tour Correlations
Grade 9-12

HS-LS1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can: **(1) Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.** [Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. (2) **Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.**

Disciplinary Core Ideas: LS1.A: Structure and Function

Systems of specialized cells within organisms help them perform the essential functions of life.

Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system.

Nimbus Correlation: Euryhaline osmoregulation allows salmon to control the level of salt within their bodies in both fresh and saltwater environments, taking in more salt through the gills in freshwater and to excrete excess salt through the gills when in saltwater.

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can: (1) Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. (2) Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. (3) Evaluate the 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. (4)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.] (5) Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

Disciplinary Core Ideas: 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.

Nimbus Correlation: Natural limits to carrying capacity restrict the population of salmon and steelhead in the American River. Human-caused constraints, such as dams, further limit the carrying capacity of the river. Nimbus Hatchery was built in order to sustain a viable population large enough to meet commercial and sport fishing needs and also fulfill the salmon and steelhead's role in the ecosystem.

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.
Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.

Nimbus Correlation: A range of physical and environmental conditions affect the salmon population from year to year, and numbers can fluctuate dramatically without indicating real problems. However, large-scale changes to the physical environment caused by global warming, pollution, water diversions, invasive species, etc. are presenting real and significant challenges to the survival of salmon as a species.

LS2.D: Social Interactions and Group Behavior

Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.

Nimbus Correlation: Salmon swim in schools, out migrate at about the same time, and return to the river in concentrated runs in order to increase their survival and the survival of their genes.

HS-LS4 Biological Evolution: Unity and Diversity

Students who demonstrate understanding can: (1) Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. (2) Construct an explanation based on evidence that the process of evolution primarily results from four factors: (a) the potential for a species to increase in number, (b) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (c) competition for limited resources, and (d) the proliferation of those organisms that are better able to survive and reproduce in the environment. (3) Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. (4) Construct an explanation based on evidence for how natural selection leads to adaptation of populations. (5) Evaluate the evidence supporting claims that changes in environmental conditions may result in: (a) increases in the number of individuals of some species, (b) the emergence of new species over time, and (c) the extinction of other species. (6) Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Disciplinary Core Ideas: LS4.B: Natural Selection

Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population.

Nimbus Correlation: Those salmon best suited to survival in the unique conditions of their natal stream, as well as to the rigors of outward and return migration and ocean survival, have a higher likelihood of surviving to reproduce and pass on their genes, thereby increasing the occurrence of these successful traits in the population.

LS4.C: Adaptation

Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. Natural selection leads to adaptation; that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.

Adaptation also means that the distribution of traits in a population can change when conditions change. Changes in the physical environment, whether naturally occurring or human induced,

have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species.
Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost.

Nimbus Correlation: Generation after generation of salmon has returned to its natal stream to spawn, which has resulted in reproductively isolated spawning populations with specialized adaptations for their natal habitat. Changes to the Sacramento and American Rivers have impacted salmon and steelhead populations.

LS4.D: Biodiversity and Humans

Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

Nimbus Correlation: Maintaining the unique fall-run American River Chinook salmon strain is valuable both for its contribution to biodiversity and for its inspirational and recreational importance to humans.

HS-ESS3 Earth and Human Activity

Students who demonstrate understanding can: (1) **Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. (2) Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. (3) Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. (4) Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.**

Disciplinary Core Ideas: ESS3.A: Natural Resources

Resource availability has guided the development of human society.
All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.

Nimbus Correlation: Folsom Dam was constructed in part as a power generation facility. Retention and release of water for the purpose of power generation affects salmon and steelhead in the river, and is managed with this relationship in mind.

ESS3.B: Natural Hazards

Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations.

Nimbus Correlation: Flooding along the lower American River had significant effects on the human populations along its banks and led to the push to build Nimbus and Folsom Dams. The dammed river has provided a steady source of water for urban, industrial, and agricultural development in the region.

ESS3.C: Human Impacts on Earth Systems

The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

Nimbus Correlation: Fishing closures, bag and possession limits, and gear restrictions are set in order to manage the take of fish by commercial and sport anglers. Regulation and management of development, agriculture, forestry, and other human activities also affects natural resources.

ESS3.D: Global Climate Change

Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.

Nimbus Correlation: CDFW scientists and others continue to monitor the effects of climate change on snowpack, sea levels, weather patterns, and other variables that may affect salmon and steelhead populations.