

Cross-Reference Guide: Science 20 Alberta Science with Project WILD and Below Zero *

Unit D: Changes in Living Systems	Project Wild*	Below Zero*
<p>General Outcome 1 <i>Students will analyze ecosystems and ecological succession in the local area and describe the relationships and interactions among subsystems and components.</i></p>		
Specific Outcomes for Knowledge		
<p>20-D1.1k investigate and analyze an aquatic or a terrestrial local ecosystem, distinguish between biotic and abiotic factors, describe how these factors affect population size and</p> <ul style="list-style-type: none"> • infer the abiotic effects on life; <i>e.g., light, nutrients, water, temperature</i> • infer biotic interactions; <i>e.g., predator-prey relationships, competition, symbiotic relationships</i> • infer the influence of biota on the local environment; <i>e.g., microclimates, soil, nutrients</i> 	28 Habitat Lap Sit 57 Water Wings 62 Water Plant Art 92 Eco-Enrichers 105 Riparian Retreat 109 Water Canaries 131 Good Buddies 137 The Thicket Game 147 Quick Frozen Critters 150 Classroom Carrying Capacity 153 Muskox Manoeuvres 156 How Many Bears Can Live in This Forest? 165 Micro Odyssey (m) 168 Wetland Metaphors 180 Blue Ribbon Niche 188 Rainfall and The Forest 206 Oh Deer! 227 Checks and Balances 237 Migration Headache 283 The Glass Menagerie 286 Too Close For Comfort 289 Shrinking Habitat 299 Deadly Links 319 Deadly Skies 363 Turtle Hurdles	33 Winter Survival 41 Snow Place Like Home 49 Snowsense 53 Snug Under the Snow 55 Fishy Deep Freeze 65 It's a Gasp 69 The Great Escape 73 Whine and Dine 77 Moose Morsels 107 Winter Buddies 129 What Gall! 147 Kindness that Kills!

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Specific Outcomes for Knowledge		
<p>20–D1.2k describe the key stages of primary succession in a specific ecosystem and the nature of its climax community; e.g., <i>spruce bog, sand dune, pond, prairie</i></p>	133 Forest in a Jar 135 Pond Succession	
<p>20–D1.3k differentiate between primary and secondary succession in a specific aquatic and a specific terrestrial ecosystem, e.g., <i>pond, river, lake, forest, parkland</i>, and compare natural and artificial means to initiate secondary succession in an ecosystem, e.g., <i>reforestation or regrowth after a forest fire, flood or other natural disaster, strip mining, clearcutting, controlled burns by some Aboriginal groups promoting grassland biome regeneration</i></p>	133 Forest in a Jar 135 Pond Succession	
<p>20–D1.4k describe the potential impact of habitat destruction on an ecosystem</p>	180 Blue Ribbon Niche 216 Here Today, Gone Tomorrow 227 Checks and Balances 232 Net Gain, Net Effect (m) 237 Migration Headache 245 Where Have All the Salmon Gone? 276 Water We Eating? (e#2) 289 Shrinking Habitat 293 Migration Barriers 295 To Compromise or Not To Compromise 310 Aquatic Times (m) 312 To Dam or Not To Dam 319 Deadly Skies	131 Snakes and Ladders 137 Snowmobile Savvy 141 Shocking Snow! 145 The Acid Test 151 An Ice Place to Be! 155 Mighty Migrators (m)

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Specific Outcomes for Knowledge		
20-D1.4k describe the potential impact of habitat destruction on an ecosystem	322 Deadly Waters 337 Flip The Switch For Wildlife 354 Dragonfly Pond 363 Turtle Hurdles	
20-D1.5k describe the effects of introducing a new species into, or largely removing an established species from, an environment; <i>e.g., zebra mussel, carp and the Eurasian milfoil in Canada's lakes, purple loosestrife in Alberta, the horse or the buffalo in the plains region of Alberta.</i>	220 Who Lives Here? 222 Planting Animals 242 Aquatic Roots	

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Specific Outcomes for Science, Technology and Society (STS) (Social and Environmental Contexts Emphasis)		
20-D1.1sts describe how society provides direction for scientific and	<ul style="list-style-type: none"> • <i>discuss public support of scientific work on predator-prey relationships as part of wildlife management in</i> 222 Planting Animals 227 Checks and Balances	69 The Great Escape (indirect)

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technological development (SEC4) [ICT F2–4.4]	<i>national and provincial parks (introduction of wolves, for example)</i>		
20–D1.2sts explain that society and technology have both intended and unintended consequences for humans and the environment (SEC3) [ICT F2–4.8, F3–4.1]	<ul style="list-style-type: none"> • <i>discuss, in terms of scientific principles, how reforestation projects change the direction of secondary succession in a natural ecosystem</i> 		
	<ul style="list-style-type: none"> • <i>assess the long-term implications of fire control and prevention on population and ecosystem stability, diversity and productivity</i> 	224 SmokeyThe Bear Said What?	
	<ul style="list-style-type: none"> • <i>assess habitat loss and the responsibility of society to protect the environment for future generations</i> 	180 Blue Ribbon Niche 216 Here Today, Gone Tomorrow 227 Checks and Balances 232 Net Gain, Net Effect (m) 237 Migration Headache 245 Where Have All the Salmon Gone? 276 Water We Eating? (e#2) 289 Shrinking Habitat 293 Migration Barriers 295 To Compromise or Not To Compromise 310 Aquatic Times (m) 312 To Dam or Not To Dam 319 Deadly Skies 322 Deadly Waters 337 Flip The Switch For Wildlife 354 Dragonfly Pond 363 Turtle Hurdles	131 Snakes and Ladders 137 Snowmobile Savvy 141 Shocking Snow! 145 The Acid Test 151 An Ice Place to Be! 155 Mighty Migrators (m)
<ul style="list-style-type: none"> • <i>analyze the need for habitat reclamation, such as recreating wetlands and swamps, forests, and prairie grasslands, and describe steps to ensure species diversity.</i> 	180 Blue Ribbon Niche (e#2) 306 Planning For People and Wildlife (m) 348 Improving Wildlife Habitat in the Community		

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Specific Outcomes for Skills (Social and Environmental Contexts Emphasis)			
Initiating and Planning 20–D1.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues	<ul style="list-style-type: none"> • <i>design a model to explain the relationship between populations of predator and prey, outlining the characteristics of each that adapt them to their trophic level (IP–NS2)</i> 	147 Quick Frozen Critters 153 Muskox Manoeuvres 163 Owl Pellets 172 Marsh Munchers 180 Blue Ribbon Niche (var, e#1) 319 Deadly Skies	69 The Great Escape 73 Whine and Dine
	<ul style="list-style-type: none"> • <i>inquire into the effect of logging on predation levels of deer as well as on food sources for deer (IP–NS1)</i> 	206 Oh Deer!	
	<ul style="list-style-type: none"> • <i>design an experiment and identify specific variables to investigate relationships between biotic and abiotic elements of a micro-ecosystem (IP–NS2)</i> 	109 Water Canaries 283 The Glass Menagerie 319 Deadly Skies	17 Cold Busters 45 Snow Experiments 49 Snowsense 53 Snug Under the Snow 99 Snow Floats 103 Winter Wonders 123 The Benefit of Big (m) 125 Cozy in the Cold 141 Shocking Snow! (m) 145 The Acid Test
	<ul style="list-style-type: none"> • <i>evaluate and select appropriate procedures and technology to measure the impact of introducing species X into a specific environment (IP–NS4) [ICT C6–4.5].</i> 	220 Who Lives Here? 222 Planting Animals 242 Aquatic Roots	

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Specific Outcomes for Skills (Social and Environmental Contexts Emphasis)			
Performing and Recording 20–D1.2s conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information	<ul style="list-style-type: none"> • perform a field study; measure, qualitatively and quantitatively, appropriate biotic and abiotic factors in the aquatic or terrestrial ecosystem chosen; and present data in a form that describes, in general terms, the structure of the ecosystem; <i>e.g., pH, temperature, precipitation, water hardness, turbidity, dissolved oxygen content, humidity, wind, light intensity, soil composition, plants, animals, micro-organisms</i> (PR–NS4) [ICT C6–4.2] 	72 Puddle Wonders! 98 Environmental Barometer 109 Water Canaries 127 Urban Nature Search (m) 191 Where Does Water Go After School? 283 The Glass Menagerie 376 Watershed	11 Look at the Snow 15 Bird Banquets (m) 27 Twiggy Tales 41 Snow Place Like Home 49 Snowsense 53 Snug Under the Snow 129 What Gall! 141 Shocking Snow!

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Specific Outcomes for Skills (Social and Environmental Contexts Emphasis)			
	<ul style="list-style-type: none"> • <i>use library and electronic research tools to collect information on a given topic, such as:</i> <ul style="list-style-type: none"> – <i>protection of the environment as a priority over economic interest</i> – <i>endangered species of the world</i> – <i>the Convention on Biological Diversity</i> – <i>sustainable development initiatives</i> (PR–NS4) [ICT C1–4.1, C3–4.2]. 	70 Designing a Habitat 109 Water Canaries (e#7) 118 Kelp Help 180 Blue Ribbon Niche 184 Hooks and Ladders 216 Here Today, Gone Tomorrow 230 No Water Off A Ducks Back 232 Net Gain, Net Effect 237 Migration Headache 242 Aquatic Roots 299 Deadly Links (e#2) 322 Deadly Waters (e#3,4) 354 Dragonfly Pond 348 Improving Wildlife Habitat in the Community	137 Snowmobile Savvy

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Specific Outcomes for Skills (Social and Environmental Contexts Emphasis)			
Analyzing and Interpreting 20–D1.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions	<ul style="list-style-type: none"> • analyze field study data to identify the interrelationships of biotic and abiotic components of the ecosystem studied; <i>e.g., dominant plants, micro-climates and habitats, niches and interrelationships of biota</i> (AI–NS1, AI–NS2) [ICT C7–4.2] 	72 Puddle Wonders! 109 Water Canaries 188 Rainfall and The Forest 245 Where Have All the Salmon Gone? (m) 283 The Glass Menagerie 319 Deadly Skies	11 Look at the Snow 15 Bird Banquets (m) 27 Twiggy Tales 41 Snow Place Like Home 45 Snow Experiments (part 1) 49 Snowsense 53 Snug Under the Snow 99 Snow Floats 103 Winter Wonders 129 What Gall! 141 Shocking Snow!
	<ul style="list-style-type: none"> • <i>tabulate, graph and interpret relevant data collected from observations of succession in a micro-climate (hay infusion, for example)</i> (AI–NS2) [ICT C6–4.3] 	133 Forest in a Jar (m)	
	<ul style="list-style-type: none"> • <i>analyze statistical data in diagrams, tables and graphs as part of a briefing for a public hearing on a proposed mineral exploration in an ecologically or a culturally sensitive area</i> (AI–NS2, AI–NS3, AI–NS4) [ICT C7–4.2] 		

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Specific Outcomes for Skills (Social and Environmental Contexts Emphasis)			
	<ul style="list-style-type: none"> • <i>analyze the information presented by opposing sides on an environmental issue, such as that of an environmental group and that of an industry representative, to determine bias (AI-NS4, AI-SEC1) [ICT C2-4.1, C2-4.2]</i> 	211 The Hunter 295 To Compromise or Not To Compromise 312 To Dam or Not To Dam 328 Ethi-Thinking 340 Ethi-Reasoning 354 Dragonfly Pond	137 Snowmobile Savvy
	<ul style="list-style-type: none"> • <i>identify new questions that arise from investigations, such as: "Should naturally occurring forest fires be fought?" (AI-NS5).</i> 		
Communication and Teamwork 20-D1.4s <i>work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results</i>	<ul style="list-style-type: none"> • <i>elicit feedback from others on an environmental issue (CT-NS1)</i> 	257 Changing Attitudes 306 Planning For People and Wildlife 328 Ethi-Thinking 340 Ethi-Reasoning 354 Dragonfly Pond	147 Kindness that Kills!
	<ul style="list-style-type: none"> • <i>participate in a variety of electronic group formats to gather and share information about environmental issues (CT-NS1) [ICT C5-4.2]</i> 		
	<ul style="list-style-type: none"> • <i>prepare a visual display that explains initiatives undertaken by industry to protect the environment (CT-NS2) [ICT P4-4.2].</i> 		

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<p style="text-align: center;">Specific Outcomes for Knowledge</p>		
<p>20–D2.1k outline the biogeochemical cycles of nitrogen, carbon, oxygen and water and, in general terms, describe their interconnectedness, building on knowledge of the hydrologic cycle from Science 10, Unit D</p>	50 How Wet is Our Planet? 57 Water Wings 191 Where Does Water Go After School? 322 Deadly Waters 381 Alice In Waterland 354 Dragonfly Pond	11 Look at the Snow 53 Snug Under the Snow 55 Fishy Deep Freeze 65 It's a Gasp 141 Shocking Snow!
<p>20–D2.2k describe artificial and natural factors that affect the biogeochemical cycles:</p> <ul style="list-style-type: none"> • nitrogen cycle; e.g., <i>automobile, agricultural and industrial contributions to NOx combining with water to produce nitric acid, nitrogen in manure and fertilizers</i> • carbon cycle; e.g., <i>emissions of carbon oxides from extraction, distribution and combustion of fossil fuels, releases associated with deforestation and cement industries</i> • water cycle; e.g., <i>extraction of ground water, dams for hydro-electricity and irrigation</i> 	50 How Wet is Our Planet? 57 Water Wings 191 Where Does Water Go After School? 230 No Water Off A Ducks Back 299 Deadly Links 283 The Glass Menagerie 310 Aquatic Times 312 To Dam or Not To Dam 319 Deadly Skies 322 Deadly Waters 337 Flip The Switch For Wildlife 328 Ethi-Thinking 371 Something's Fishy Here! 381 Alice In Waterland	141 Shocking Snow! 145 The Acid Test

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Specific Outcomes for Knowledge		
<p>20–D2.3k analyze and describe how energy flows in an ecosystem, using the concepts of conservation of energy (second law of thermodynamics); energy input and output through trophic levels, food webs, chains and pyramids; and specific examples of autotrophs and heterotrophs</p>	46 What's For Dinner? 163 Owl Pellets 172 Marsh Munchers (m) 299 Deadly Links 368 Plastic Jellyfish	55 Fishy Deep Freeze
<p>20–D2.4k explain why population size and biomass are both directly related to the trophic level of the species and explain how trophic levels can be described in terms of pyramids of numbers, biomass or energy</p>		

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Specific Outcomes for Science, Technology and Society (STS) (Social and Environmental Contexts Emphasis)			
20-D2.1sts explain that science and technology have both intended and unintended consequences for humans and the environment (SEC3) [ICT F2–4.8, F3–4.1]	<ul style="list-style-type: none"> • <i>assess whether the efforts to reduce human impact on biogeochemical cycles are viable, taking into consideration a variety of perspectives (considerations for deep-well and deep-ocean injection of wastes, for example, include properties of waste, concentration, uncertainty, environmental concerns, risks and benefits to human health and organisms, costs)</i> 	230 No Water Off A Ducks Back 299 Deadly Links (e#2,3) 319 Deadly Skies (e#7) 371 Something's Fishy Here!	
	<ul style="list-style-type: none"> • <i>evaluate the influence of society, and the impact of a variety of technologies, on the nitrogen cycle</i> 		

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	<ul style="list-style-type: none"> • <i>discuss the use of water by society, the impact such use has on water quality and quantity in ecosystems, and the need for water purification and conservation, considering such things as manufacturing, the oil industry, agricultural systems, the mining industry and domestic daily water consumption</i> 	<p>50 How Wet is Our Planet? 55 Aqua Words 57 Water Wings 168 Wetland Metaphors 191 Where Does Water Go After School? (e#3) 230 No Water Off A Ducks Back 262 Watered Down History 299 Deadly Links 312 To Dam or Not To Dam 319 Deadly Skies 322 Deadly Waters 332 Water's Going On?! 337 Flip The Switch For Wildlife 340 Ethi-Reasoning (aq) 354 Dragonfly Pond 371 Something's Fishy Here! 376 Watershed 381 Alice In Waterland</p>	<p>141 Shocking Snow! 145 The Acid Test 151 An Ice Place to Be!</p>
<p>20-D2.2sts explain that science and technology are developed to meet societal needs and expand human capabilities (SEC1) [ICT F2-4.8]</p>	<ul style="list-style-type: none"> • <i>contrast the diet of people in developing countries and that of people in developed countries in terms of energy efficiency and environmental impact, and describe ways to address potential food shortages in the future.</i> 		

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Specific Outcomes for Skills (Social and Environmental Contexts Emphasis)			
Initiating and Planning 20–D2.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues	<ul style="list-style-type: none"> • <i>design an investigation to compare the carbon dioxide production of plants with that of animals (IP–NS1, IP–NS2, IP–NS3, IP–NS4)</i> 		
	<ul style="list-style-type: none"> • <i>hypothesize how alternations in the carbon cycle as a result of the burning of fossil fuels might affect other biogeochemical cycles (sulfur, iron and water, for example) (IP–NS3)</i> 		
	<ul style="list-style-type: none"> • <i>predict disruptions in the nitrogen cycle that are caused by human activities (IP–NS3).</i> 		
Performing and Recording 20–D2.2s conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information	<ul style="list-style-type: none"> • <i>draw, by hand or using technology, annotated diagrams of energy flow in food chains, webs and pyramids (PR–NS4).</i> 		55 Fishy Deep Freeze

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Analyzing and Interpreting 20–D2.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions	<ul style="list-style-type: none"> • describe alternative ways of presenting energy-flow data for ecosystems: pyramid of biomass, of numbers or of energy (AI–NS4, AI–NS5, AI–NS6) 		
	<ul style="list-style-type: none"> • <i>evaluate the relevance, reliability and adequacy of data and data-collection methods, including assessing the authority, reliability and validity of electronically accessed information</i> (AI–NS4) [ICT C3–4.1, C3–4.2] 		
	<ul style="list-style-type: none"> • <i>evaluate the appropriateness of a technology, such as deep-well injection of wastes, to solve a problem</i> (AI–SEC2) [ICT C6–4.5]. 		
Communication and Teamwork 20–D2.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and	<ul style="list-style-type: none"> • <i>use advanced menu features within a word processor to insert tables, graphs, text and graphics in food webs and energy budgets for various trophic levels in an ecosystem</i> (CT–NS2) [ICT P4–4.3] 		

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Specific Outcomes for Skills (Social and Environmental Contexts Emphasis)			
ideas and in assessing results	<ul style="list-style-type: none"> • <i>make arguments on an issue such as the expansion of housing and other amenities in Banff National Park or Jasper National Park (CT–SEC3) [ICT C2–4.1, C7–4.2]</i> • <i>work cooperatively in a group to investigate the influence of human activities on the biogeochemical cycles and, using appropriate multimedia, present the findings (CT–SEC1, CT–SEC2) [ICT P3–4.1].</i> 	340 Ethi-Reasoning 348 Improving Wildlife Habitat in the Community	
		262 Watered Down History 322 Deadly Waters 328 Ethi-Thinking (m) 337 Flip The Switch For Wildlife 340 Ethi-Reasoning (m) 354 Dragonfly Pond 376 Watershed	141 Shocking Snow! 145 The Acid Test

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Specific Outcomes for Knowledge		
<p>20–D3.1k describe mutation as the principal cause for variation of genes in species and populations, identify the role of sexual reproduction in generating variability among individuals and describe the forces that drive evolution</p>		
<p>20–D3.2k describe the adaptation of species over time due to variation in a population, population size and environmental change; <i>e.g., bacterial resistance to antibiotics, giraffe neck length, gazelle speed</i></p>	137 The Thicket Game (m) 139 Adaptation Artistry 142 Seeing Is Believing or The Eyes Have It! 147 Quick Frozen Critters 197 Fashion a Fish	
<p>20–D3.3k describe evidence for evolution by natural selection; <i>e.g., fossils, biogeography, embryology, homologous and vestigial structures, biochemical research</i></p>		
<p>20–D3.4k compare gradual evolution with punctuated equilibrium</p>		
<p>20–D3.5k describe how factors including space, accumulation of wastes (<i>e.g., salinization of soil</i>), competition, technological innovations, irrigation practices (<i>e.g., Hohokam farmers</i>) and the availability of food impact the size of populations</p>	28 Habitat Lap Sit 153 Muskox Manoeuvres 156 How Many Bears Can Live in This Forest? 184 Hooks and Ladders 206 Oh Deer! 211 The Hunter 227 Checks and Balances	33 Winter Survival 41 Snow Place Like Home 69 The Great Escape (m) 131 Snakes and Ladders 137 Snowmobile Savvy 141 Shocking Snow 145 The Acid Test 147 Kindness That Kills!

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Specific Outcomes for Knowledge		
	245 Where Have All the Salmon Gone? 286 Too Close For Comfort 289 Shrinking Habitat 299 Deadly Links 335 What did Your Lunch Cost Wildlife? 337 Flip The Switch For Wildlife	151 An Ice Place To Be!
20–D3.6k compare the growth pattern of the human population to that of other species.		

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Specific Outcomes for Science, Technology and Society (STS) (Nature of Science Emphasis)			
20-D3.1sts explain that scientific knowledge and theories develop through hypotheses, the collection of evidence through investigation and the ability to provide explanations (NS2)	<ul style="list-style-type: none"> • <i>discuss the nature of science as a way of knowing, considering the contributions of Buffon, Lyell, Malthus and Wallace to the theory of evolution</i> 		
	<ul style="list-style-type: none"> • <i>describe how paleontology has provided invaluable data in the attempt to explain observable variations in organisms (horse, fish) over time</i> 		
	<ul style="list-style-type: none"> • <i>compare Lamarckian and Darwinian explanations of evolutionary change.</i> 		

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Specific Outcomes for Skills (Nature of Science Emphasis)			
Initiating and Planning 20–D3.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues	<ul style="list-style-type: none"> design an investigation to measure or describe an inherited variation in a plant or an animal population (IP–NS1, IP–NS2, IP–NS3, IP–NS4). 		
Performing and Recording 20–D3.2s conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information	<ul style="list-style-type: none"> gather data, actual or simulated, on organisms to demonstrate how inherited characteristics change over time; e.g., <i>Darwin’s finches, bacteria, domestic plants and animals</i> (PR–NS1, PR–NS4). 		
Analyzing and Interpreting 20–D3.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions	<ul style="list-style-type: none"> analyze data, actual or simulated, on organisms to demonstrate how inherited characteristics change over time; e.g., <i>Darwin’s finches, bacteria, domestic plants and animals</i> (AI–NS2) [ICT C7–4.2] 		
	<ul style="list-style-type: none"> demonstrate and assess the effect of environmental factors on population growth curves (AI–NS2, AI–NS6) [ICT C7–4.2] 	206 Oh Deer!	

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Specific Outcomes for Skills (Nature of Science Emphasis)			
	<ul style="list-style-type: none"> • <i>use calculated or actual data to graph the growth of populations that demonstrate exponential growth and logistic growth (AI-NS2) [ICT C6-4.2, C6-4.3]</i> 	206 Oh Deer!	
	<ul style="list-style-type: none"> • <i>apply the growth curve for open populations to identify the long-term impact on Earth's carrying capacity and the demands on natural resources for a growing human population (AI-NS2, AI-NS4, AI-NS6)</i> 		
	<ul style="list-style-type: none"> • <i>analyze the processes governing the growth pattern of human populations that are different from those governing naturally occurring populations (AI-NS2) [ICT C7-4.2].</i> 		
Communication and Teamwork 20-D3.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	<ul style="list-style-type: none"> • <i>discuss Darwin's impact on modern science and society (CT-NS1).</i> 		

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* **End Notes** (for all tables)

bold - very strong correlation of activity with outcome/expectation

m - minor modification required for SLE

- relevant step in activity procedure

e - include extension activity

aq - aquatic extension

eval - evaluation section of activity

var - variation section of activity

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