CHILDREN'S ENVIRONMENTAL KNOWING:

A CASE STUDY OF CHILDREN'S EXPERIENCES DURING AN ENVIRONMENTAL EDUCATION PROGRAMME

by

SANDRA ANNE SCOTT

B.A., The University of British Columbia, 1980

M.A., The University of British Columbia, 1997

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
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ABSTRACT

This study explores children's experiences during WaterWorlds (pseudonym) a field-based environmental education programme at a marine science centre. The study objectives were to investigate how children understand and interpret their experiences, and how these experiences foster their environmental knowing.

To address these objectives, I carried out a case study at a marine science centre in British Columbia. I examined children's WaterWorlds experiences and explored their environmental understandings and commitment to environmental action. I analysed the experiences of children in four separate classes and carried out an in-depth examination of four individual children. Data were collected using informal semi-structured interviews, observations, conversations, researcher journal logs, and student documents including their writing and illustrations.

My findings indicate that the WaterWorlds programme experience fosters children's environmental knowing. Participation in WaterWorlds activities led to connection, caring, and concern for other species and in some cases, for the marine environment as a whole. During the programme, children chose the ways they interpreted and expressed their environmental knowledge, ethic of care, advocacy, and commitment to action. This development of each child's self-expression resulted in motivational and powerful learning experiences that inspired and nurtured their connections to the earth.

This research provides evidence and examples of how educators can foster children's environmental knowing through multi-disciplinary environmental education

experiences. It illustrates that activities such as observing and documenting the lives of other animal species, collecting data and conducting research on those species, and working and learning alongside experts in the field of environmental education are powerful experiences that motivate concern and care for the earth among children.

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DEDICATION

I dedicate the following chapters to my Boundary Bay, Bowen Island, and Point Roberts companions who shared with me a lifelong journey to Environmental Knowing. Memories of our many forays into the natural world guided, informed, and inspired this narrative. These words are for my brother Peter, best friend Eleanor, sisters Jill and Dianna, our little family Silesia, Doug, and Mac, and for my parents, George and Helen Scott, who provided the opportunity for all of us to know, respect, and love the communities within the tides, forests, and skies.

CHAPTER ONE
INTRODUCTION TO THE STUDY

Prologue

> I loved being with my observation animal and spending every morning together. I've read about him in books and now I've lived his life. We have a deep connection; It's priceless and forever. (Claire, Grade 6, interview, February 13, 2004)

These words were spoken by Claire on her final day of WaterWorlds, an environmental education programme at a marine science centre in British Columbia, Canada. Claire and the other children in her Grade 6 class spent five days studying aquatic flora and fauna at the Centre. The focal point of the WaterWorlds programme is the "observation animal", a resident animal each child selects to observe, study, and research. The children spent one hour each day documenting their animal observations in a field journal.

Claire's final thoughts differ markedly from those voiced on her first day when I asked her about prospective observation animals. She responded by characterizing all aquarium animals as "brainless" and "boring". That first morning, Claire sat alone during gallery explorations, doodling in her journal as her classmates excitedly rushed about in search of an observation animal. By day's end, everyone had a myriad of prospective candidates and found it difficult to select just one. Unlike her peers, Claire's observation animal quest remained unfulfilled.

I asked Claire if I could join her during Animal Observations. The following morning, I discovered her by a small exhibit in the tropical gallery transfixed by a

diminutive creature clinging to a branch of coral. Noticing my presence she remarked, "I've decided to observe Vinegar," pointing to a pale-hued seahorse, "He needs me!" (Claire, Grade 6, conversation, February 9, 2004). Over the next few days I visited Claire as she documented Vinegar's morning routine in her journal. She compiled field notes and sketches on her animal's appearance, behaviour, and food preferences and examined his relationships with other seahorses. She dedicated poetry and songs to her "pale friend", crafted narratives about his "lonely life", and congratulated him on his impending fatherhood. By the end of the programme week, Claire described Vinegar as her "kindred spirit" and "soul mate". She vowed to compose and perform songs in the seahorse's honour so others would "understand and appreciate" this remarkable fish and "help save his species from pollution and over-harvesting." (Claire, Grade 6, interview, February 13, 2004).

Introduction

Claire's story provides the entry for this study of children's experiences in the WaterWorlds environmental education programme. Claire's initial reaction to choosing an observation animal is atypical when compared to her classmates, but her developing bond with Vinegar and her resultant feelings of caring and connection are characteristic of the relationship children forge with the animal they choose and observe during the programme. Claire's dramatic journey and those of the other children I have observed in this setting inspired me to inquire into children's learning in this environmental education setting.

This study of children's experiences examines how this kind of environmental education can contribute to the development of environmental knowing. My research originates from my love and concern for the natural world, a lifelong passion for environmental education, and a profound curiousity about children's interactions with, and their interpretations and understanding of nature. During my Masters work on children's beach experiences, I found that learners developed strong bonds with intertidal organisms. The children revealed their feelings of caring and connection for specific animals and for the beach environment as a whole.

Prior to this dissertation research I spent time working as the WaterWorlds coordinator and observed children connecting with aquatic animals. The observation animal appeared to provide a lens through which the children could view both the environmental significance and problems of a species. For some children, this connection appeared to lead to an interest in and concern for the aquatic realm as a whole. These observations strengthened my curiousity about the ways environmental education experiences can develop and nurture children's environmental knowing.

The Problem

The growth of the human species is a global problem, and through our very existence, we are devouring this planet and leaving our children a legacy of pollution, waste, destruction, illness, and hunger. The World Conservation Union's (2006) Red List of endangered plants and animals increased by five hundred species from 2004 to 2006. The conservation group cites "melting ice caps", "dying deserts", and "empty oceans" as harbingers of "a clear trend" in global biodiversity loss and clearly identifies people as

responsible for the world's burgeoning environmental crises (World Conservation Union, 2006, p.1). The World Wildlife Fund's (2006) Living Planet Report states that the earth's terrestrial, marine, and freshwater vertebrae species have declined by thirty percent since 1970 and predicts a large scale ecosystem collapse by 2050 if the present rate of biodiversity loss continues. Human actions upon the earth are causing irreversible harm to the natural world. One way for people to understand and ultimately take informed action to solve environmental problems is through environmental education (Gough, 2002; Hungerford, Bluhm, Volk, & Ramsey, 2001; Hungerford & Volk, 1990; Orr, 1999; Oskamp, 2002; Tbilisi Declaration, 1977; The Earth Charter, 2000).

If we hope to halt this tide of environmental plunder, we must understand how to promote caring, connection, and commitment for the earth and all living things. Environmental researchers and practitioners claim that effective environmental education must begin at a young age and connect children with natural and community places through direct experience (Carson, 1965; Gruenewald, 2005; Kruse & Card, 2004; Orr, 1991, 1999; Sobel, 2004). They recommend an approach that involves learning about the earth through science, aesthetics, ethics, and socio-cultural history with a goal of taking action to solve environmental problems (Hart, Jickling, & Kool, 1999; Orr, 1992; Sterling, 2001). Others speak directly to the link between the development of environmental caring and connection and children's direct experience and interactions with 'special places' and non-human species (Abram, 1996; Fawcett, 2000, 2002; Hart, 1997; Kahn & Kellert, 2002; Pyle, 2002; Sobel, 2004; Vining, 2003). Environmental practitioners and classroom teachers cite the need for an interdisciplinary environmental education. They ask for practical examples of learning experiences that promote

environmental caring and connection and information on where to place these experiences within the school curriculum (Jarnet & Marquis, 2001).

Educators and environmentalists define environmental education as education that promotes development of awareness, knowledge, attitudes, and participation with a global commitment to respect, care for, and love for all of the earth communities (Tbilisi Declaration, 1977; The Earth Charter, 2000). They offer guidelines and state goals, but provide few examples that help with the teaching of environmental education. Educational researchers propose curriculum models intended to develop learners' environmental knowledge, skills, attitudes, and behaviours (Hart, Jickling, & Kool, 1999; Hungerford & Volk, 1990; Orr, 1992; Selby, 1995). These models of curriculum imply a comprehensive multi-disciplinary and interdisciplinary environmental education that sounds good in writing but is more difficult to imagine in practice. Practitioners struggle to teach from these models and place environmental education in the classroom curriculum.

While much has been written about what environmental education should accomplish, few studies examine children's learning experiences (Hart, 1997; Hart & Nolan, 1999; Rickinson, 2001), and how such experiences influence their environmental knowing (Hart 2001; Payne, 1998, 2005). Research that has been conducted suggests that building relationships with the earth through in-depth and intimate observations and interactions with non-human animals fosters children's feelings of care, connection, and commitment for the environment (Chawla, 1999, 2002; Hart, 1997; Fawcett, 2000; Kellert, 2002; Schultz, Shriver, Tabanico, & Khazian, 2004; Sobel, 1995, 1996). Zoos and aquaria provide the opportunity for interaction with non-human species, yet studies

conducted on education programmes in these contexts focus primarily on exhibit information and what visitors learn from displays and typically do not examine learners' emotional responses or the development of caring for other species (Dierking, Burtnyk, Buchner, & Falk, 2002; Myers, Saunders, & Birjulin, 2002; Vining, 2003). Thus, there is a need for more research on closing the gap between environmental education theory and practice and moving beyond rhetoric to reality.

The Study

The purpose of this study is to investigate children's experiences in the context of an educational programme at a marine science centre in order to understand their environmental learning and knowing.

The following research questions frame this study:

1. How do children understand and interpret their experiences in an environmental education programme at a marine science centre?
2. How do the experiences in the programme foster environmental knowing among the children?

To answer my research questions I conducted a naturalistic case study of children's experiences at WaterWorlds (pseudonym) a five-day, experiential, field-based environmental education programme at a marine science centre in a large city in British Columbia, Canada. The study was conducted between October, 2003 and June, 2004. Four classes of elementary children from three different schools took part in the study. I participated in each class's WaterWorlds week and documented my observations and the

children's behaviours, conversations, and WaterWorlds work in my research journal. The study data included interviews, field observations, conversations, and documents of the children's WaterWorlds work. These data enabled me to examine connections between the children's experiences, their learning, and environmental knowing. I drew upon these multiple data sources to establish validity and ensure credibility of the research findings through triangulation.

Terms of Reference

I introduce a number of terms in this dissertation. In this section of the chapter I define each of those terms:

Multi-disciplinary education: The term multi-disciplinary education refers to teaching and learning that encompasses knowledge from across content areas (Hungerford & Volk, 2002) and academic disciplines including the sciences, social sciences, and the arts (Thompson-Klein, 1998).

Interdisciplinary education: The term interdisciplinary education refers to teaching and learning that integrates ideas, methods, practices, research, and information from a range of disciplines (Epstein, 2004) and incorporates skills for acquiring, analysing, synthesizing, and evaluating information (Hungerford & Volk, 2002).

Cross-curricular: The term cross-curricular refers to teaching and learning across school subject area curricula such as science, math, social studies, language arts, and the fine arts.

Holistic education: The term holistic education refers to balanced learning that encompasses multiple layers of meaning and experience and places equal value on emotional, physical, spiritual, cognitive, and aesthetic development (Miller, 2000).

Systems thinking and systems theory: The terms systems thinking and systems theory refer to the connection among mind, matter, and life and an understanding of the human and non-human world as an interconnected and interdependent living system (Capra, 1996).

Environmental knowing: Environmental knowing is a way of understanding and interpreting the world that encompasses environmental knowledge, an ethic of environmental care, and environmental advocacy and action.

Environmental knowledge: Environmental knowledge refers to an awareness and understanding of the diversity of life and of biodiversity, ecosystems, the interdependence of natural and human communities, and whole systems, as well as knowing what can be done about environmental problems (Frick, Kaiser, & Wilson, 2004).

Direct experience: The term direct experience refers to any experience involving physical contact with non-human species within natural settings (Kellert, 2002) and within programmed contexts such as zoos and aquaria.

Significance of the Study

The significance of this study that examines children's environmental education experiences lies in the following areas.

- First, this study provides an empirical examination of the link between environmental education theory and practice.
- Second, this study's findings may help teachers who wish to implement a multi-disciplinary environmental education approach within the school or classroom setting.
- Third, this study will assist educators who seek to design environmental education programmes that can influence children's environmental knowing

Organization of the Thesis

This thesis is presented in seven chapters. I begin Chapter One with a narrative of one child's WaterWorlds story to introduce the study context and explain my interest in this subject area. I then outline the research problem citing the gap between theory and practice in environmental education and the need for studies of children's environmental education experiences. I follow with a statement of the research questions. I then describe my research methods, the study's significance, and conclude the chapter by outlining the organization of the thesis.

In Chapter Two, I summarize and review the literature that informs and supports this study. I examine literature related to environmental education as a discipline, environmental education curricula and programmes, and literature on children's knowing. Chapter Three describes and justifies my study's research methodology and methods. I describe the context and outline my procedures for data collection, analysis, methods, and address the validity and limitations of my research design. I conclude with a discussion of ethical considerations and my reflections on my researcher role.

Chapter Four presents vignettes illustrating the five day WaterWorlds programme. I highlight the range of events the children participate in during WaterWorlds, and describe the nature of these experiences. In Chapter Five I present my findings on children's environmental understandings and actions based on my analysis of interviews and children's documents from four classes of elementary children who participated in the WaterWorlds programme.

In Chapter Six, I present the cases of four children who represent a different range of grade levels, socio-cultural backgrounds, and WaterWorlds experiences. I analyze the children's experiences to illustrate how their participation contributed to their environmental knowing. In Chapter Seven, I summarize the research findings, discuss my conclusions, consider the implications of the study for the practice of environmental education, and offer suggestions for future research and practice in environmental education.

CHAPTER TWO

REVIEW OF THE LITERATURE

As a naturalist, educator, guide, and researcher, I have witnessed children develop environmental caring and connection through direct experiences with the natural world. In this research study, I sought to investigate children's environmental learning by investigating children's experiences in WaterWorlds, an environmental education programme in a marine science centre on the west coast of British Columbia, Canada. In the WaterWorlds programme, teachers and their classes spend five days at the Centre engaging in experiential and learner-centred activities. Each of the children chooses a Centre animal to study, and they record their observations, interactions, and reflections in a field journal.

The goal of the WaterWorlds programme is to develop the children's environmental understanding and their conservation and environmental knowledge (Education Programmes, 2005). WaterWorlds' philosophy, curriculum, and practice are informed by Falk and Dierking's (1992) research on museum learning, Duckworth's (1996) study on the ways children make sense of their own ideas, and Gardner's (1993) theory of multiple intelligences.

In this chapter, I situate my study within the literature on environmental education as a discipline, environmental education curricula and programmes, research that examines environmental education in practice, and literature on children's environmental knowing.

Environmental Education as a Discipline

Environmental education for the twenty-first century is interdisciplinary, cross-curricular, and holistic. Effective environmental education encompasses formal and non-formal learning (Barney, Mintzes, & Yen, 2005; Volk & Cheak, 2003) and follows a goal of citizenship behaviour and informed and responsible action (Cullen, 2001; Marcinkowski, 2001; Winther, 2001) while embracing ethics and an ethic of care (Cheney & Weston, 1999; Evernden, 1985; Jickling, 2004; Weston, 1998), commitment, social justice, and a global world view (Cajete, 2000, Hungerford & Volk, 1990; Jickling, 2005; Orr, 1992; Sobel, 2004). In what follows, I review the work of theorists, researchers, and practitioners who support this vision of effective environmental education and offer definitions and models for the practice of "good environmental education" (Staniforth, 2002; Thomson, 2002).

Environmental education has its roots in nature study, outdoor education, and conservation education (Disinger, 2001; EETAP, 1997). These interdisciplinary and multi-disciplinary educational movements paralleled "the beginnings of reaction against the university ideal of the compartmentalization of education" (EETAP, 1997, p.1). The nature study movement originated in 1891 as part of an educational reform that advocated experiential rather than textbook driven learning in American schools (EETAP, 1997; Kohlstedt, 2005). The outdoor education movement that began in the 1920's was similar to nature study in that both promoted experiential learning that integrated classroom and out-of-school learning. Conservation education grew out of environmental concerns of the 1930s such as the "dust bowl" drought and focused on learning about natural resource management. A number of movements followed

including resource-use education, population education, and more recent elements such as marine and aquatic education (EETAP, 1997).

Although these past reform initiatives inform both the theory and practice of today's environmental education, many researchers regard environmental education as a distinct discipline due to its focus on the interconnectedness of people and their environment (Disinger, 2001; Disinger & Monroe, 1994). Kirk (1977) and later Grieg, Pike, and Selby (1987) state that environmental education was established as a distinct discipline in 1965 with a specific philosophy and methodology and credit scientist Rachel Carson's (1962) seminal work Silent Spring as the harbinger of environmental awareness and education on a global scale. The term environmental education was first defined in 1969 by William Stapp in the inaugural edition of the Journal of Environmental Education. Stapp's (1969) definition was a reaction to the world's burgeoning environmental problems:

> Environmental education is aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution. (pp. 30-31)

International organizations further defined environmental education during a series of United Nations sponsored conferences. Fontes (2004) writes that based on "the most common dating" (p.148) environmental education was "born" in 1972 during the International Conference on the Human Environment held in Stockholm, Sweden. He adds that it was more clearly defined and delineated during ensuing conferences held in response to the earth's escalating environmental crises. These conferences resulted in the Tbilisi Declaration (1977), which extends Stapp's (1969) definition, to incorporate the development of environmental caring, concern, and informed and responsible action.

The Tbilisi Declaration was adopted by United Nations Educational, Scientific, and Cultural Organization (UNESCO) as the accepted definition of environmental education.

More recently, The Earth Charter (2000) was drafted in an attempt to build upon the Tbilisi model of developing environmental awareness, knowledge, attitudes, skills, and action and incorporate the missing elements of respect and care for the community of life, ecological integrity, social and economic justice, democracy, non-violence, and peace. The Earth Charter's purpose was to address the needs of an "increasingly interdependent and fragile" world "to bring forth a sustainable global society founded for nature, universal human rights, and economic justice, and a culture of peace" (Earth Charter, 2000, p.1). Although these conferences expanded environmental education's definition and purpose, they did not provide concrete ideas for teaching or examples of experiences to achieve these goals.

Environmental Education Curricula and Programmes

The past fifty years have resulted in many definitions of environmental education with assuredly more to come as the world experiences additional environmental problems involving ecological, economic, and social issues. To locate practical models and concrete examples of how to teach environmental education, I next review the literature on current environmental education curricula and programmes. This study takes place in British Columbia, Canada so I examine curricula produced by the Canadian federal government and the B.C. Ministry of Education.

Environment Canada's, A Framework for Environmental Learning and Sustainability, FELS, (Government of Canada, 2002) was published in response to

UNESCO's call during the Earth Summit (United Nations Conference on Environment and Development, 1992, 1996) for nations to develop environmental education and sustainable development strategies. FELS (2002) focuses primarily on strategies for knowledge development and action plans such as developing support programmes, websites, conferences and symposia to improve networking opportunities for individuals, researchers, and practitioners. The document does not provide examples of learning experiences or ideas for curriculum placement. Although the stated purpose of A Framework for Environmental Learning and Sustainability (2002) is to educate Canadians to become more "ecologically literate" and "incorporate sustainability into their everyday lives" (p. 3), there are no directives on how to accomplish these goals. Also concepts such as "ecologically literate" and "sustainability" need to be clearly defined before educators can be expected to teach toward them (Jickling, 2001, 2003a).

The province of British Columbia Ministry of Education's (1995a, 2005) prescribed elementary science curriculum places environmental education within life sciences, but the practical component of 'what and how to teach' is absent. The recently revised B.C. Integrated Resource Package (IRP) for Elementary Science (B.C. Ministry of Education, 2005) states that the goal of environmental education is for students to learn scientific skills, processes, and attitudes to investigate the diversity, community, interactions, and balance among organisms. Although the IRP (2005) provides a space in the curriculum for environmental education, the document does not include concrete examples of learning experiences that accomplish this goal. The IRP (2005) does not incorporate ethics and affective elements such as care, nor does it deliberate advocacy and action as educational goals.

In 1995, the B.C. Ministry of Education published Environmental Concepts in the Classroom (ECC) to provide teachers with a thematic framework for environmental education. The purpose of ECC (B.C. Ministry of Education, 1995b) was to address the absence of environmental education in the B.C. elementary school curriculum and help teachers and administrators implement environmental education from kindergarten to Grade seven (Robertson, 1998). Although ECC provided practical suggestions for teachers and guidelines for bridging theory and practice (Zandvliet, 2001), there was a lack of concrete ideas on "how to go about doing environmental education" (Lott & Courtenay-Hall, 1998).

Environmental Concepts in the Classroom (B.C., 1995b) was updated and revised resulting in the publication of Conceptualizing Environmental Learning (Draft) (B.C. Ministry of Education, 2006). The acronym C.A.R.E , which stands for Complexity, Aesthetics, Responsibility, and Environmental Ethic, is used in this document as "a mnemonic and metaphor" (B.C. Ministry of Education, 2006, p. 11) to describe a "new approach" to a "CAREing" and "green curriculum" for schools in British Columbia (Bridge, 2006). The document covers kindergarten to Grade 12, and provides principles for organizing and conceptualizing environmental education. The intent of Conceptualizing Environmental Learning (B.C. Ministry of Education, 2006) is to help teachers integrate the concepts of C.A.R.E. into their curriculum through the teaching of interdisciplinary environmental education that fosters environmental knowledge, ethics, and action. Examples of C.A.R.E. in practice are not included in the draft document, but educators will have access to lesson ideas through curriculum links in a forthcoming "companion website" (Bridge, 2006).

The curricula characterized by the Canadian Federal and B.C. Provincial documents included here provide definitions, organizing frameworks, guidelines, themes, and concepts for environmental education. The newest B.C. initiative Conceptualizing Environmental Learning (B.C. Ministry of Education, 2006) addresses the need for curriculum integration and incorporates the cognitive and affective domains, environmental ethics, and action. Yet, I find that these publications lack concrete examples of the 'doing' of environmental education. As this review shows, educators have numerous definitions and conceptual frameworks to draw upon, but the documents still lack concrete pedagogical examples being called for by classroom teachers who are asking for ideas on how to teach environmental education (Jarnet & Marquis, 2001). To search for this 'missing' practical component, I now examine the writings by environmental thinkers that deal with how environmental education programmes should appear in practice.

Environmental thinkers conceptualize effective environmental education encompassing the "physical, cognitive, spiritual (emotional) domains" (Zandvliet, 2001, p.41), ethics (Botzler & Armstrong, 1993; Evernden, 1985; Jickling, 2004), goals of citizenship behaviour and responsible and informed action (Cullen, 2001; Hungerford & Volk, 1990; Marcinkowski, 2001; Winther, 2001), and a global world view of culture and community (Bowers, 1999; Gruenewald, 2005; Orr, 1992). However, once again a review of this literature shows a lack of examples on how teachers can translate these ideals into practice. Hungerford, Peyton, and Wilke's (1980) "seminal work" (Cullen, 2001) on instructional goals for environmental education focuses on the development of skills, knowledge, attitudes, and behaviour but does not include any discussion of

experiences that lead to these outcomes. Orr's (1992) Foundations for Earth Centred Education advocates a trans-disciplinary curriculum but does not indicate what trans-disciplinary learning involves in terms of teacher and student "doing" and curriculum links. Selby (1995) states that his Humane Classroom develops a global view of environmental issues and enhances the skills and mindset necessary for informed action, but does not offer practical ideas on how to create this learning context. Volk (2001) provides a comprehensive overview of curriculum planning, organization, and evaluation but does not include specific lesson ideas.

Kellert (1985, 1987, 1996, 2002) establishes a connection between children's experiences with nature and their cognitive, affective, and evaluative (values oriented) development. His "Values of Nature Typography" defines different ways children understand, interact with, and interpret the natural world through aesthetic, dominionistic (mastery/control over nature), humanistic, moralistic, naturalistic, negativistic, scientific, symbolic, and utilitarian values. Kellert (2002) provides both theory and data to support his claim that children's intellectual, emotional, and "values-related development" (p.146) is enhanced through direct, varied, and ongoing experiences in the natural world. Although Kellert's (2002) model links children's "ages and stages of development" with learning during environmental education experiences, he does not provide concrete examples of experiences or ideas on curriculum placement.

Hart, Jickling, and Kool (1998,1999) provide the most useful account of what effective environmental education looks like in practice. They propose that environmental education should lead to informed and responsible environmental action. Further, they argue that environmental education should encompass four areas of

understanding: ecology and environmental science through the study of complex systems including thermodynamics, population concepts, communities and ecosystems, interaction, interdependence, and co-evolution; environmental aesthetics and spirituality through development of intuition, insight, respect, deep familiarity, and compassion for the natural world; environmental ethics and philosophy through the study of values, philosophical premises, beliefs, and future visions of different cultures; and environmental history through the study of how different cultures and societies have acted in relation to their environment and the outcomes of these actions. Hart et al (1999) claim that through experiences based on these understandings, learners will acquire an awareness and sensitivity to the environment and a sound knowledge of environmental issues, problems, and solutions. Learners will also develop feelings of care and concern for the environment, skills for solving environmental problems, the ability to critically evaluate environmental issues, and the motivation to take action to implement environmental solutions.

I find that Hart, Jickling, and Kool's (1999) concept for environmental education agrees with my understanding of multi-disciplinary environmental education. It encompasses the teaching and learning of science, aesthetics, ethics, history, and action and recognizes the significance of children developing feelings of care and commitment for the natural world. The authors also outline content areas to help educators identify curriculum links. Although Hart et al (1999) present a clearer picture of environmental education's multi-disciplinary nature in the curriculum and address the cognitive and affective domains, ethics, and environmental action, the intent of their work was not to provide practical examples of activities, lessons, and experiences.

Sauvé's recent work (2005) builds upon Hart, Jickling, and Kool's (1999) concept of environmental education and provides concrete examples of instructional strategies. Sauvé (2005) expands Hart et al's (1999) understandings of environmental education to include humanist, feminist, holistic, bioregionalist, ethnographic, socially critical, and sustainability perspectives. My study will contribute to Hart et al's (1999) and Sauvé's (2005) dialogue on environmental education by providing an empirical account of children's environmental learning.

Environmental Education in Practice

The literature does contain some research that examines the link between the theory and practice of environmental education. Staniforth and Fawcett (1994) provide ideas for developing environmental education curriculum packages, teaching units, and workshops. They focus on environmental awareness through direct experience, ecological and natural history connections, culture, nature, and political and environmental action for social change. Staniforth (2002) creates additional recommendations for "good environmental education". She advocates teaching rigorous content including well researched facts and data, ecological principles such as systems thinking, "love" and the "three C's" of caring, connection, and concern, values thinking and values analysis, questioning, critical thinking, controversy, and environmental issues. Staniforth (2002) recommends that educators address learning stages, ages, and culture, and engage students through long-term contact with natural places including peer teaching, action learning, and community involvement.

Sobel (2004) presents examples of successful environmental education initiatives taking place in classrooms as well as in natural and community places. He concludes that place-based environmental education not only improves student achievement but also develops learners' problem-solving and decision-making skills, and enables them to transfer their learning to additional environments. Smith and Williams (2004) describe the fieldwork of practitioners who facilitate programmes aimed at developing learner's ecological literacy, observation-inquiry-discovery, and biophilia[1]. They provide examples of environmental education in practice that recognize the link between human culture and the environment, and address global environmental issues including hunger, resource management, and integrating Western Science within indigenous cultures. Sobel (2004) and Smith and Williams (2004) define "good" environmental education and provides concrete examples of curriculum models, lesson ideas, and learning experiences for environmental education practitioners. Yet there is a need for additional empirical studies on children's environmental education experiences that incorporate these elements and how these experiences foster environmental knowledge, caring, and concern for the earth.

In the section that follows, I summarize literature that addresses the nature of learning that occurs through multi-disciplinary environmental education experiences. Such learning has the potential to foster children's environmental knowledge but also their ethic of care, advocacy, and commitment to action, what I define as environmental

[1] Biologist E.O. Wilson (1984, 1993) defined biophilia as "the innate tendency to affiliate with natural things", and the emotions involved in the experience (Verbeek & de Waal, 2002, p.1).

knowing. I begin with a description of 'knowing' and relate this to published work on caring and children's relationships with non human species of animals. I conclude with a discussion of the literature that envisions action as a goal of environmental education and argue that commitment to action is also a component of environmental knowing.

Children's Environmental Knowing

Bruner (1985, 1986) characterizes knowing as narrative and paradigmatic forms of thought that involve both scientific and aesthetic learning. Paradigmatic thought is associated with logic, math, and science; narrative thought with the humanities. Eisner (1994) describes knowing as process driven and states that children's knowing is fostered through learning experiences which enable them to find meaning, go beyond the boundaries of "right answers" (p.78), and transfer their knowledge to the outside world. Bruner (1986) asserts that ways of knowing combine "good stories" with "good theory" (p.13), and Eisner (1998) concludes that when educators value and incorporate children's knowing, they encourage exploration, expressivity, discovery, and imagination. Bruner (1985) and Eisner (1994, 1998) emphasize scientific and aesthetic modes of knowing but do not speak to the full range of understanding and interpreting the world called for by environmental education writers. However a number of researchers have begun to address this gap through examining children's learning and understanding of environment in a variety of education settings.

Snively (1986) conducted a case study of Grade 6 students' experiences and beliefs during a beach field trip and concluded that children interpret the world through frameworks that they construct to describe and explain their learning. Using an interview

based approach, Snively identified "orientations" or interpretative frameworks which learners constructed to describe and explain their seashore knowledge. The children held utilitarian, aesthetic, scientific, spiritual, recreational, and health and safety orientations. Snively found that some children maintained preferred orientations while all learners held a range of orientations throughout the study.

In a later study, Snively and Cummins (2000) investigated Grade 4 students' knowledge, attitudes, and "stances toward marine resource issues" (p. 302) during classroom and field trip experiences. They analysed data from questionnaires and the children's drawings and writings and found that experiential learning within local habitats fostered children's interest, respect, and caring for the natural world. They also found that students' stances or the "specific course of action" taken "in a given resource conflict situation" (p.302) were either conservationist, exploitive, or preservationist. Although Snively (1986) and Snively and Cummins (2000) do not discuss their findings on children's learning in terms of ways of knowing, I suggest that the orientations and stances they identify represent different ways children 'know' the natural world.

Payne (2005) also examined seashore experiences in a case study of one learner's scientific and aesthetic "ways of knowing ... in and about a beach place" (p.108). He investigated a Grade 12 student's perspectives and experiences in response to a class assignment. Payne noted that as the student's beach activities were "planned, ordered, disciplined, and task driven" (p.119), there was a lack of spontaneity in both "approach" and "conduct" (p.120). That is, he found that the "intensity, poignancy, and power" (p.122) of the beach encounters diminished as the student concentrated on the written component of the assignment. Payne's (2005) findings support the value of experiential,

exploratory, and multi-disciplinary learning and the link that scientific and aesthetic ways of knowing have with environmental education. He also cites the need for more studies on children's knowing in multi-disciplinary and experiential learning settings. My study will address this need by investigating additional ways children know the world, and how these ways of knowing inform and are reflected in their environmental learning.

The research conducted by Snively (1986), Snively and Cummins (2000), and Payne (2005) informs my understanding of children's environmental knowing, but their work does not specifically focus on the ways children develop an ethic of care for the earth. To investigate environmental caring as a way of knowing, I now review the literature on children's caring and whether their ethic of care may extend to the natural world through participation in environmental education experiences.

Researchers find that education is instrumental in developing children's ability to care for and about others (Bronfenbrenner, 1979; Noddings, 1985, 2005) and some claim that close relationships with nature, specifically with non human animals, may play an important role in enabling children to develop natural caring for the environment (Fawcett, 2004; Sobel, 1995, 1996; Vining, 2003). Noddings (2005) states that children develop caring through "co-feeling" which involves a shift from the child's personal needs to the needs of others. She claims that when children experience caring themselves, they begin to care about others and develop ethical caring, an extension of care to others.

Empirical studies investigating children's relationships with the environment find a link between children's direct experiences with other animal species and environmental care. Hart (1997) writes that children's caring relationships with the earth's non-human

residents lead to caring for the environment as a whole. He states that children's environmental caring begins with empathy and evolves with direct experiences with the natural world and contact with non-human animals. To achieve these outcomes Hart (1997) recommends that educators focus on learning that develops children's environmental knowledge, caring and concern, and commitment to action. Myers and Saunders (2002) also propose that children's "natural caring" extends to the environment through direct contact with animals in natural local habitats as well as in zoos and science centres. They write that when children experience deep feelings for other animals, they develop knowledge and an understanding of the animal's needs, the interconnectedness of ecosystems, and the effect of human actions on the earth. Kellert (2002) finds that children develop affection and emotional connection, and ethical and spiritual affinity for natural settings and non-human species through direct, indirect, and vicarious experiences with nature.

Fawcett (2000, 2002) provides ideas for developing an ethic of care and knowing for the natural world. In her essay on environmental learning and teaching, she writes that story-telling and composing environmental biographies enable students to listen to and engage with others and reflect upon their own experiences. Fawcett also emphasizes that long-term "in situ" observation of common local organisms will deepen learners' "collective ethical imaginations" (p.146). In her study of Kindergarten to Grade 5 students' direct experiences with wild animals, Fawcett (2002) explored an "ecosystem" of stories and drawings and examined ideas on friendship, concerns about freedom, anthropomorphism, and inter-species bonds and fears. Fawcett found that children "came

to know themselves" both as mammals and as part of a multi-species community by understanding "other" animals.

Sobel (2004) reports that when children engage in in-depth observation of animals they develop empathy, a biophilia or "ecophilia", the biological tendency to bond with the natural world. Mortari (2004) investigated the ethic of care of students in Grade 1-5 during a year long, school-based environmental education project. Due to the logistics of the classroom setting, plants were used as the objects of care rather than animals. The study's findings indicated that children held "world views" (p.121) which informed their ethic of care. Mortari (2004) also noted that the concrete practice of care in combination with "the task of reflecting and writing about their lived experiences" (p. 121) produced significant changes in the students' attitudes and concluded that "time will tell" (p. 121) in determining the effectiveness of experiences involving caring.

Mayer-Smith, Lee, Bartosh, Peterat, Sinkinson, and Tsepa (2004) investigated Grade 7 students' caring during their study of children's participation in a farming project. The children teamed with farming elders, and together they planted, nurtured, and "cared for" a variety of plants and vegetables. The study's findings indicated that this joint venture between children and city-based farmers that focused on nurturing the land, promoted environmental concern, care, and "closer connections to the earth" (2004, p. 11). Mortari's (2004) and Mayer-Smith et al's (2004) studies are significant as both provide practical examples of ways children develop an ethic of care for nature during a field based environmental education programme. Their studies along with Fawcett's (2002) and Sobel's (2004) suggestions for developing an ethic of care for the earth resonate with my view that care is a central component of environmental knowing.

In addition to care, an important element of environmental knowing is informed and responsible action (Hart, Jickling, & Kool, 1999). The literature describes environmental action as a code of behaviour (Tbilisi, 1977), action skills (Hungerford, Peyton, & Wilke, 1980), citizenship behaviour (Hungerford & Volk, 1990), active involvement (Orr, 1992), civic responsibility (NAEE, 1996), responsible change (Selby, 1999), informed action (Hart, Jickling, & Kool, 1999), environmental citizenship (Hargrove, 2000), social justice (Earth Charter, 2000), activist learning (Chase, 2000; Whelan, 2002), democratic participation (Woodhouse & Knapp, 2000), citizenship action (Winther, 2001), educating for sustainability (Moore, 2004; Huckle & Sterling, 1996; Sterling, 2001), environmentally responsible behaviour and environmental literacy (Hungerford, 2002), and place-based community action and interaction (Gruenewald, 2005; Sobel, 2004). These many descriptors imply that environmental action requires the development of skills, knowledge, and attitudes, as well as caring, connection, and commitment for both the human and non-human world.

Smith-Sebasto and Fortner (1994), Marcinkowski (2001), and Winther (2001) present the most comprehensive and multi-disciplinary definition of environmental action that encompasses educational, ecological, legal, persuasive, and consumer environmental actions. Although these authors promote a broad vision for environmental action, they do not offer concrete suggestions on how to inspire children to take environmental action.

Many theorists, researchers, and practitioners make a marked distinction between environmental action and advocacy due to advocacy's association with political or social activism (Disinger, 2005; Jickling, 2005; Johnson & Mappin, 2005; McClaren & Hammond, 2005). For the purpose of my study, I define the children's advocacy as a

process of developing awareness of environmental issues and problems and becoming an advocate on behalf of the environment. I define commitment to action as the children's proposed ideas for solving specific environmental problems. The literature provides numerous definitions and frameworks for environmental action and advocacy, but I sought and found minimal evidence of the kinds of environmental education experiences that inform and inspire children to take action.

Summary

The world's environmental problems are escalating and current educational initiatives are not meeting the growing need. Environmental education has changed significantly from its comparatively simple nature-study origins to embrace the cognitive and affective domains, ethics, all the world's communities, and a goal of responsible and informed action. Educators are expected to teach more than experiential outdoor education as current frameworks advocate experiences that develop environmental knowledge, skills, and attitudes, inspire action, and address ecological, social justice, and economic issues within a global context. This review investigated environmental education concepts and curricula as well as empirical studies of environmental education programmes. It showed that little is understood about the holistic impact of experiential environmental education on children's learning. This case study which investigates children's environmental learning in a marine science centre will contribute insights into ways we can foster children's environmental knowing.

CHAPTER THREE

METHODOLOGY

This is a study of children's experiences during an environmental education programme conducted in a marine science centre, and an examination of how those experiences inform children's environmental knowing. In this chapter, I describe the study context and the participants. I also discuss methodology and detail the methods I used to collect and analyze data in order to answer the research questions. I conclude with comments on ethical considerations and limitations of the study and then reflect on my researcher role.

Context of the Study

This study was conducted in three elementary schools and at a large marine science centre in British Columbia. The focus of the study was an environmental education programme I have titled WaterWorlds. The programme consists of a five day aquatic field experience for elementary school children that occurs in the marine science centre's indoor and outdoor galleries. The galleries house flora and fauna from both temperate and tropical environments and feature West Coast marine species. The programme's activities are designed to be experiential and hands-on.

Teachers who are interested in having their class participate in the WaterWorlds programme must first attend an information session at the Centre and then submit a conservation-themed proposal. The proposal guidelines specify that teachers identify a set of field experiences that they would like their students to participate in and detail how

these activities will be integrated into the teacher's classroom lessons before and after the WaterWorlds experience.

Every teacher who applies to WaterWorlds is interviewed by the Centre's education staff, and participants are selected based on their proposal. Successful proposals have a strong conservation message and are supported by hands-on, student-centred, and interdisciplinary classroom and field activities. Teachers who are selected attend a three day summer workshop that prepares them for the WaterWorlds programme. During workshop sessions, they participate in a range of activities their students will experience including Animal Observations, the Wet Lab, and the Artefacts Discovery session. Following the workshop, every teacher meets with the WaterWorlds coordinator, five weeks prior to their field experiences to discuss specific events and prepare a detailed schedule for the five day onsite experience. The coordinator provides the teacher with information about Centre animals, marine biology fact sheets, science articles, and suggests classroom activities that will help the teacher prepare students for the WaterWorlds programme.

Once the actual programme begins, the children travel by bus with their classmates, teacher, and parent and school volunteers to the marine science centre on each of the five consecutive days. Each day the children spend approximately five hours in pre-organized activities and record their experiences in a journal. WaterWorlds events include gallery activities, Expert Talks with Centre staff, a Behind-the-Scenes Tour, Wet Labs, and one hour per day of Animal Observations. As each WaterWorlds visit is individually planned by the coordinator and classroom teacher, the order of these activities varies. A description of each activity is provided in Figure 3.1.

Events	Description
Expert Talk	Expert Talks can be lecture format or interactive. The children take part in at least one talk facilitated by a science centre expert in their field.
Behind-the-Scenes Tour	The Behind-the-Scenes tour is led by the programme coordinator and Centre volunteers. The children tour the marine science centre to learn about daily operations including the facility's history, on-site research studies and to observe and ask questions of staff as they work
Wet Lab	The Wet Lab is an on site teaching laboratory that houses living local intertidal species. The children study an array of invertebrates such as seastars and crabs through observational and tactile experiences.
Animal Observations	Every child chooses a Centre animal for a close-up study. They observe their animal for one hour each morning and record their experiences in a field journal.

Figure 3.1 Description of WaterWorlds Events

The Study Participants

The participants in this study were elementary students who had taken part in the WaterWorlds programme during the 2003-2004 school year. During that school year, 21 classes of children from 19 schools participated in WaterWorlds. Four classes of students from three schools in three different school districts took part in the study. These classes represented a diverse student population that included children with a wide range of socio-economic and cultural backgrounds and included special education students and First Nations learners.

One Grade 4 class of 27 students (ages 9-10) from Mariner Elementary School attended WaterWorlds in November, 2003 and participated in the study. Mariner Elementary is situated near the Pacific Ocean and enrols children from an adjacent First Nations reserve and the surrounding middle class residential neighbourhood. The school has approximately 200 students, and 35% of the children come from First Nations families. Mariner Elementary parents are actively involved in the school and provide academic and cultural support by facilitating literacy, fine arts, cultural, and early intervention programmes.

One Grade 6 class of 28 students (ages 11-12) from Oceanview Elementary participated in WaterWorlds in January 2004 and took part in the study. Oceanview Elementary enrols approximately 350 students from a multicultural neighbourhood that includes upper-middle, middle, and lower income families, and First Nations families living on a nearby reserve. Oceanview Elementary offers fine arts, late French immersion, and a regular stream programme, and has one full time school staff member who serves as a child care worker and another who provides support for Aboriginal

students and families. The Grade 6 class that participated in the study was part of the regular programme stream and included one First Nations student.

One class of fifteen Grades 4/5 students (ages 9-12) and one class of fifteen Grades 6/7 students (ages 11-12) from Evergreen Elementary School participated in WaterWorlds in February 2004 and took part in the study. Evergreen Elementary enrols approximately 420 students and is an inner city school. Evergreen is located in a multi-cultural neighbourhood of middle and lower income families and has a high English as a second language (ESL) student population. The children who took part in the study were those enrolled in the school's two Special Education Language Needs (LN) classes. Students are admitted to Evergreen's LN classes based on their "inability to reach their academic potential in a regular setting due to a severe language deficit" (Special Education Manual, 2004-2005, p.44). The LN students who participated in the study were identified as having a language disorder and were at least two years behind in their language development. Information about the participating schools and students is presented in Table 3.1.

Table 3.1: Participating Schools and Students

School Name	Students	Grade	Neighbourhood Demographics
Mariner Elementary	27	4	Middle income/First Nations
Oceanview Elementary	28	6	Upper Middle/Middle/Lower income First Nations
Evergreen Elementary	30	4/5/6/7	Lower/Middle income/Special Needs

Methodology

My love and concern for the natural world and my experiences as an environmental educator and researcher bring me to this study of children as they engage in an environmental education programme. In my youth, I was a self-taught naturalist, cruising the sandbars with like-minded companions. I passionately shared my experiences, knowledge, and reflections of the intertidal world with my friends and family and engaged in inquiry with them about the kinds of marine animals we encountered, their behaviours, possible friends and foes, and their mysterious high-tide lives. We dedicated ourselves to 'saving' animals from the predatory hordes of gulls, crows, and 'unenlightened' people who, to our dismay, were quick to harvest anything that moved. During these rescue missions, we blanketed vulnerable bivalves with sand, separated battle-locked crabs (we later learned they were mating), transported land-stranded fish to open water, and flung soon-to-be desiccated seastars into the ocean depths. Today, when we re-visit our beloved intertidal stomping grounds, we continue these same activities of exploration, investigation, examination, and emancipation.

I have observed children commune in similar ways with the natural world, building close and caring relationships with animals both in wild and human constructed places and this led me to wonder what role, if any, environmental education might play in provoking and fostering these dispositions and actions. To explore and understand this issue, I required a methodology that would allow me to look in depth at children's environmental experiences, nature relationships, and ways of learning.

To understand children's experiences in this environmental education programme, I adopted a naturalistic case study approach. Merriam (1998) describes the

case study as a holistic process leading to in-depth understanding and meaning making and finds that a case study approach is suited to studies of events, programmes, institutions, or social groups when the purpose it to provide a thick description of the phenomenon under investigation. This seemed ideal because my study examines children as individuals as well as in social groups as they participate in an environmental education programme.

Merriam (1998), Creswell (1998), and Stake (1995) define the case study as an in-depth exploration of a "bounded system". The term bounded refers to the event, programme, or individuals under investigation being separated out for research purposes by time and place (Creswell, 1998). In this study the bounded system is the children's experiences during five consecutive days of the WaterWorlds programme at the marine science centre.

Merriam (1988) states that the case study's strength lies in its ability to involve a wide range of evidence including interviews, conversations, artefacts, documents, and observations. Joppe (1999) agrees and advises that the case study researcher record detailed observations, conduct in-depth interviews, and glean data from a variety of documents. My study's multiple data sources include in-depth interviews, observations, field notes, photographs of events and documents, and examples of the children's work.

Merriam (1988) characterizes case studies as being particularistic, descriptive, and heuristic. A case study is particularistic as it focuses on a particular event, programme, situation, or phenomenon. It is descriptive as it produces a "thick" and "rich" description of the situation being studied. The case study is heuristic as it uncovers and illuminates in-depth understanding and discovers new meaning. My study

encompasses all these characteristics as I focus on the WaterWorlds programme and incorporate thick descriptive narratives to identify, describe, and illuminate the children's experiences to provide understanding and uncover meaning.

Stake (2000) describes three kinds of case studies and defines them as intrinsic, instrumental, and collective. The intrinsic case study focuses on the uniqueness of the case by looking at a specific situation. The instrumental case study focuses on an issue or issues, and the case is used instrumentally to illustrate the issue(s). The collective case study researches a number of cases at one time. I regard my study as a collective case study because I report on cases of individual children as well as more general description of the programme and its influence on many of the children.

Stake's (2000) notion of collective case study refers to research that investigates a number of single cases or multiple cases within a study. Other researchers refer to a multi-case study design as cross case studies, comparative case studies, and contrasting cases (Merriam 1998; Yin, 2003). Regardless of the label, a study involving multiple cases enables the researcher to provide deeper understanding and uncover meaning by investigating individual cases and looking across cases to produce commonalities and differences (Merriam, 1998; Yin, 2003). Multi-case studies are found to be "more compelling" and result in a "more robust" study overall (Yin, 2003, p. 46). The use of more than one case also can enhance the validity of the research findings (Merriam, 1998). I chose a multi-case study approach for my research as it suited my exploration of the perspectives and histories of children in four classes and supported my in-depth study of four individual children (Joppe, 1999; Stake, 2000).

Methods

Data Collection Procedures

I researched children's WaterWorlds experiences from October, 2003 to June, 2004. During this time, I interviewed the children, collected field notes, and compiled visual records through photographs and documents. Prior to their WaterWorlds field experience, I visited each class at their school once to introduce the study, explain my role, answer questions, and observe the children's work. During the WaterWorlds programme, I attended all activities. I observed and documented the children's behaviour, conversations, and interactions and conducted two informal conversational interviews with each child. I augmented my observation and interview data by collecting samples of the children's work produced as part of the programme activities and by recording their involvement through digital photographs.

After their WaterWorlds programme was over and the children returned to school, I completed a set of classroom observations and conducted a third semi-structured interview with all children who wished to participate and who had provided informed consent from their parent/guardian. All 27 students from the Mariner Grade 4 class participated in the three interviews. Eight students in Oceanview's Grade 6 class participated in all three interviews, and 19 Language Needs students from Evergreen Elementary took part in all three interviews. My research timeline is presented in Table 3.2.

Table 3.2 The Timeline of the Research

Events	Event 1 Classroom Visit	Event 2 Water Worlds Field Trip	Event 3 Interview 1	Event 4 Interview 2	Event 5 Interview 3 and Classroom Visit
Description	visited school to explain study and ethics forms.	accompanied class during their field trip.	conducted first interview.	conducted second interview.	conducted third interview.
Participants					
Mariner Elementary	Nov. 19, 2003	Nov. 24-28, 2003	Nov. 24, 2003	Nov. 25-28, 2003	Feb. 11-13, 2004
Oceanview Elementary	Jan. 10, 2004	Jan. 12-16, 2004	Jan. 12, 2004	Jan. 13-16, 2004	March 5, 2004
Evergreen Elementary	Feb. 13, 2004	Feb. 16-27, 2004	Feb. 16, 23, 2004	Feb. 17-27, 2004	May 27-28, 2004

Interviews

I conducted both informal and semi-structured interviews with the children to elicit their responses to WaterWorlds experiences. Hatch (2002) describes interviews as special kinds of conversations that enable researchers to explore participants' experiences and interpretations. The informal interview is unstructured, conversational, and occurs in the study site while the semi-structured interview is researcher-led, audio-taped, and typically is conducted during a set time frame within a venue selected by the interviewer (Eisner, 1991; Hatch, 2002; Merriam, 1998). A combination of informal and semi-structured interview techniques is recommended for studies involving children (Diamond, 1999; Falk & Dierking, 2000; Hein, 1998).

My interviews were open-ended. As there were no set response categories, I was able to ask each child similar questions and allow for individual and unique answers (Diamond, 1999; Fontana & Frey, 2000). Interviews that include both open-ended and informal formats are best suited for ESL students, shy children, and those lacking confidence in their verbal abilities (Diamond, 1999). During my interviews, I found that the approach worked well with all students, including the Language Needs classes from Evergreen Elementary.

I employed the three-interview approach recommended by Seidman (1998) to document any changes in the children's understanding over time and to avoid the thin results of the "one-shot" interview. The first interview took place on the first day of WaterWorlds and focused on the children's prior knowledge and their initial responses to the programme. The second interview took place midway through the programme and delved into the children's daily activities. The third interview occurred two months after

the WaterWorlds programme was over and explored the children's reflections on their experiences. The three-interview format allowed me to clarify, follow-up, and expand on the children's previous interview responses.

The children had their field journals with them during all three interviews and that enabled me to ask questions about their WaterWorlds work and also provided the children with an additional focus that helped relieve any feelings of stress and unfamiliarity regarding the interview process (Diamond, 1999; Hein, 1998). I found that most children were proud of their journals and enjoyed discussing their drawings, research notes, stories, and reflections. Talking about their journal entries also helped the children explain and describe their engagement in and response to the programme. For those children who documented classroom work in their journals, I was able to view a record of their pre and post visit activities and assignments.

I conducted the first and second interviews in the science centre galleries while the children were participating in their daily Animal Observations. The third interview took place in the children's school library. Each interview was between fifteen and twenty minutes in length. The first two interviews were transcribed by hand as the children spoke with me, and the third interview was audio-taped and transcribed at a later time. I also recorded direct quotes from the children's interview responses in my research journal to help me formulate questions for subsequent interviews. All interview transcripts were converted into electronic documents for analysis.

Interviewing children requires specially worded questions that avoid jargon and technical language (Bell, Osborne, & Tasker, 1985; Diamond, 1999; Falk & Dierking, 2000; Hein, 1998; Osborne & Freyberg, 1985). I asked questions that focused on the

children's feelings and experiences, and I included the children's own words, phrases, and sentences from their interview responses in my probing, clarification, and follow-up questions. My interview questions were simple yet penetrating, neutral, non-leading, and easy to answer (Bell, Osborne, & Tasker, 1985; Eisner, 1991; Merriam, 1998). I avoided asking double-barrelled and multiple questions, and questions limited to yes or no answers (Fairburn, 1997; Merriam 1998).

I asked each child a series of similar questions for all three interviews. As recommended by Patton (2001), I created a list of questions and produced an interview protocol to provide structure and flexibility to my informal interviews and to also help me organize and analyze the resulting data. I included 'why' questions in my interview protocol as they prompted the children to elaborate on their answers and also enabled me to probe more deeply, follow up, and clarify the meaning of the children's responses (Bell, Osborne, & Tasker, 1985; Fairburn, 1997; Janesick, 1998; Lincoln & Guba, 1984; Merriam, 1998; Osborne & Freyberg, 1985; Snively, 1986). Protocols for all three interviews are included in Appendix A.

Observations

My goals were to observe and document the range of environmental education experiences the children were exposed to, record the children's engagement in and response to specific events, and to identify and record any changes over time. My observations focused on the children's interactions with peers, teachers, Centre staff, and the Centre's animals.

As suggested by Merriam (1998) and Hatch (2002) I kept written notes of my observations in a research journal to maintain an "on the spot record" (2002, p.88) of the children's experiences. I documented the children's behaviour, engagement in activities, and their responses to field experiences by detailing their conversations and interactions. I also recorded contextual details in my field notes such as names of participants and staff and times, duration, and location of activities. To supplement my observation data, I took digital photographs of the children throughout the programme. These photographs provided a visual record and additional information about the children's experiences and aided my thinking and recall of individuals and WaterWorlds events.

Documents

I collected an array of artefacts produced by students during and after their WaterWorlds visit. I studied, photocopied, and took digital photographs of the children's journals, posters, research projects, artwork, programme evaluation forms, and 'thank-you' letters. These documents provided me with additional information about the children's engagement in and responses to the programme both during and after their participation in WaterWorlds. Examples of the children's work are included in Appendix C.

My goal in looking at these documents was to understand how the children viewed and interpreted their environmental education experiences. The examination of the children's work provided me with a fuller picture of how participation in the programme informed their environmental knowing. The children's work also provided

me with "unobtrusive data" which is recommended as a measure to reduce the researcher's influence or control over the data (Hatch, 2002).

Data Analysis

My data sources included interviews, observations, and documents collected from October 2003 to June 2004 from four classes totalling 54 students. To answer my first research question on children's understandings and interpretations of their experiences in the environmental education programme, I analyzed interview and document data collected from all 54 students who attended and participated in WaterWorlds. To address the second research question on how the programme fostered environmental knowing among the children, I completed an in-depth analysis of the experiences of four individual children. I chose one boy and one girl from the Grade 6 Oceanview class, a First Nations girl from the Grade 4 Mariner class, and one boy from the Grade 5 LN Evergreen class. These children were chosen because together they were representative of the socio-cultural and educational diversity of the children in this study.

For the data analysis, I transcribed the interview tapes, read the transcripts and students' documents, and analyzed these data using the constant comparative method (Lincoln & Guba, 1985; Merriam, 1998; Strauss & Corbin, 1998). I augmented this process of analysis with a parallel reading and analysis of my observational data. To guide my analysis, I followed Bogdan and Biklen's (1992) approach to qualitative data analysis which involves working with the data, organizing it, breaking it into manageable units, synthesizing it, searching for themes and patterns, so that the researcher can discover "... what is important and what is to be learned and decide what you will tell

others" (p. 145). As suggested by Miles and Huberman (1994) and Denzin and Lincoln (2000, 2003), I began by selecting general themes to act as frames, that I further developed during analysis.

I chose Hart, Jickling, and Kool's (1998, 1999) work for my initial frames of analysis. They identify environmental science, aesthetics, ethics, and history as "key characteristics" or "understandings" for environmental education. Hart et al (1999), like other contemporary environmental scholars and practitioners, believe effective environmental education should encompass multi-disciplinary understandings and contribute to a goal of informed and responsible action. I believe that environmental action needs to be viewed as more than a goal. Environmental action is central to environmental knowing and equal in status to understanding and care. Thus I used Hart et al's 'key characteristics' to frame my inspection of how children expressed both their environmental understandings and actions in their interview responses and written work. I began by reading and identifying which data dealt with environmental understandings and which data contained discussions relating to advocacy and actions. I then conducted a two-phase analysis. First I focused on children's environmental understandings, and then I examined children's expressions of advocacy and action.

I coded the interview data using Hart, Jickling, & Kool's (1999) science, aesthetics, ethics, and history as the major themes and created subthemes for each theme, developed from Snively's (1986) orientations, Kellert's (2002) nature typography, Marcinkowski's (2001) actions, and the children's language. To code the children's responses in the documents, I again used the major themes of science, aesthetics, ethics, and history that I developed for my interview analysis. I added new subthemes for the

document data when the subthemes created for the interviews were inadequate to represent the children's non-verbal responses. This coding process was used with both children's environmental understandings and their expressions of environmental action.

In the next section I describe in more detail how I identified the major themes of Science, Aesthetics, Ethics, and History and corresponding subthemes in interview and document data. I begin with discussing my coding and analysis of the children's environmental understandings and conclude with my coding and analysis of their commitment to action. To illustrate the major themes and subthemes, I include short excerpts from the interview transcripts and document data. Subthemes are indicated in lower case italics.

I identified the theme of Environmental Science when the children's responses were associated with scientific knowledge, skills, processes, and systems thinking. Within this theme, I created the following subthemes for the interview and document data: behaviour (e.g., feeding strategies, locomotion); ecology (e.g., natural systems and interrelationships such as food webs); education (e.g., scientific learning and instruction); naturalistic (e.g. exploration of nature); physiology (e.g., reproduction); taxonomy (e.g., observable characteristics, identification of species); and research (e.g., study and experiment). The following interview and journal responses illustrate how children adopt the language of science to speak about and document their experiences:

> Wolf eels look scary and have big teeth (taxonomy), but they are friendly with other fish and people too (ecology, behaviour). They like to hang out in their cave all day with friends and family (ecology, behaviour). (Tim, Grade 4, interview, Nov 27, 2003)

> The pipefish look like a seahorse (naturalistic). I read that they are fish (educational). The pipefish always eats shrimps all day (ecology). (Brian, Grade 5 LN, journal, February 15, 2004)

I identified the Environmental Aesthetics theme in interview and document responses that incorporated feelings and emotions, spirituality, fine arts, and personal relationships. I created the following subthemes within the Environmental Aesthetics theme for the interview and document data: anthropomorphic (e.g., understanding and interpreting nature through human relationships); art (e.g., drawing, sketching, illustration, artistic and symbolic characteristics and interpretations of nature); emotions (e.g., love of nature; empathy, shared experiences, mutual feelings and emotions interest and strong affection for nature, emotional connections); family (e.g., family relationships); friend (e.g., friendship, companionship); narrative (e.g., story telling, dialogue, reflections, poems, odes, verse); sensory (e.g., physical and symbolic characteristics); and spiritual (e.g., sacred, supernatural aspects of nature). During my analysis of the data, I identified the following interview and document responses as Environmental Aesthetics:

> Well he's (sturgeon) like my grandfather (family) because he's mysterious (spiritual) and wants to be left alone (anthropomorphic). He kinda scared me at first 'cause he looks scary (sensory) and appeared all of sudden from the dark." (Faith, Grade 4, interview, Feb 12, 2004)

> The colours are so beautiful (art). (Jessie, Grade 5 LN, journal, February 16, 2004)

I identified the Environmental Ethics theme in the children's responses associated with their understandings of values about nature. I created the following subthemes within this theme for the interview and document data: conservation (e.g., conservation and anti-exploitation of nature); egocentric (e.g., human-centred); entertainment (e.g., entertainment value of nature, nature for human leisure and play); ethnocentric (e.g., nature-centred); moralistic (e.g., as concern for right and wrong), and utilitarian (e.g.,

practical/material value of nature, nature for human use, and nature as food, pet, or sport). The following interview and document excerpts illustrate the Environmental Ethics theme:

> I wouldn't mind tasting (utilitarian) my flounder. Just a little bit, especially if I was hungry (egocentric). (Dustin, Grade 4, interview, Feb 13, 2004)
> The shows are the best 'cause the animals go fast and jump very high (entertainment). They take good care of the animals here so they are happy (moralistic). (Shawn, Grade 4, programme evaluation form, November 2003)

Hart, Jickling, and Kool (1998, 1999) define Environmental History as the ways different cultures and societies have acted in relation to their environment and the outcomes of societal and cultural actions on the earth. I identified the Environmental History theme in responses incorporating understandings that were associated with personal, community, and global experiences. The following are subthemes created for the interview data and document data: culture (e.g., experiences of different cultures with nature); direct experience (e.g., 'face to face' personal interactions with nature); global (e.g., a world view of experiences with nature); local/community (e.g., local, neighbourhood, community experiences with nature); observation animal (e.g., experiences with WaterWorlds animals); personal (e.g., individual children's personal experiences); and social (e.g., the experiences of human action on the environment, experiences of human interactions with nature). The following interview and document excerpts are representative of the Environmental History theme:

> My story tells about how Wings came here from Japan (observation animal) and how he was injured (observation animal) so he can't go back in the ocean. You know they kill and eat dolphins there (cultural, global). (Joanie, Grade 7 LN, interview, May 26, 2004)

> We are brothers (personal). I am from the Wolf clan (cultural) and so is the wolf eel. (Robert, Grade 4, journal, Nov 24, 2003)

As mentioned previously I identified Commitment to Environmental Action when the children's interview and document responses included ideas for actions that would 'help' the environment. As per children's environmental understandings I coded children's action goals using the major themes of Science, Aesthetics, Ethics, and History and created subthemes within each. For the Environmental Action interview and document data, I created the following subthemes for Environmental Science: ecology (e.g., physical action that directly benefits the natural world, actions focused on natural systems, biodiversity); education (e.g., action through learning and instruction); physiology (e.g., actions focused on animal biological functions); research (e.g. action through scientific research, study, experiment); and taxonomy (e.g., action focused on observable characteristics, classification.

The Environmental Aesthetics subthemes for commitment to action included: art (e.g., action through drawing/illustration); drama (e.g., action through plays, skits, role playing); music/song (e.g., action through composing, performing, music); narrative (e.g., action through writing, story telling, dialogue, poems, odes, verse, lyrics); persuasion (e.g., motivating or inspiring others to action); video/technology (e.g., action through design and creation of film or video), and web-site design (e.g., action through e-learning, web site creation and implementation).

The Environmental Ethics subthemes for the document and interview data included: conservation (e.g., action through messages of conservation and anti-exploitation); conservation education (e.g., educating others to take action on conservation and anti-exploitation); and consumer (e.g., action through buying or not buying certain goods, through boycott or purchase power).

Environmental Action subthemes in Environmental History included: culture (e.g., action involving cultural background, ethnicity); global (e.g., actions that benefit the world, action through world-wide pressure); social (e.g., action through human and 'other animal species' interactions); local/community (e.g., taking action by placing pressure on individuals and communities); observation animal (e.g., action that benefits WaterWorlds animals); and personal (e.g., action involving children's personal history).

To organize and represent my data analysis, I created two tables and organized each by the major themes of Science, Aesthetics, Ethics, History and the corresponding subthemes. One data table summarized my analysis of the children's environmental understandings, and the second data table summarized my analysis of the children's commitment to environmental action. I created these two data tables for each child and composite data tables for each of the following: Whole Group (all 54 children), Mariner Grade 4 students, Oceanview Grade 6 students, and Evergreen Language Needs students.

I recorded the table data by reviewing each child's interview transcripts and WaterWorlds documents. When the data indicated that a child's response included an environmental understanding or environmental action, I entered a check (√) next to the corresponding subtheme in either the Science, Aesthetics, Ethics, or History themes. When the data did not indicate a child having an environmental understanding or environmental action in their response, I recorded a dash (-). For the composite data tables, I tallied and recorded the total number of children's expressions of environmental understandings and commitment to action for each group. The composite tables for Mariner Grade 4, Oceanview Grade 6, and Evergreen LN Grades 4/5/6/7 are included in

Appendix B, and the composite tables for the entire group of children are shown in Chapter Five (Tables 5.1 and 5.2).

Having the tables for the individual children allowed me to track the range and diversity of the children's environmental understandings and their commitment to action, as well as any changes over time. The composite tables provided a means of keeping track of the full set of data. They also provided a 'big picture view' of the range of children's responses to the programme and enabled me to see trends in the children's expressions of environmental understandings and actions. Two tables for John, a Grade 4 student, are presented in Tables 3.3 and 3.4.

Table 3.3 John's (Mariner Grade 4) Expressions of Environmental Understandings

		Day 1		Days 2-5		Post-experience	
THEMES	**Subthemes**	Interview	Documents	Interview	Documents	Interview	Documents
Science	behaviour	—	√	√	√	√	√
	ecology	√	√	√	√	√	√
	education	√	√	√	√	√	√
	naturalistic	√	√	√	√	√	√
	physiology	√	—	√	—	√	—
	research	√	—	√	—	√	—
	taxonomy	√	—	√	—	√	—
Aesthetics	anthropomorphic	—	—	—	—	—	—
	art	—	—	√	√	√	√
	emotions/feelings	√	√	√	√	√	√
	family	—	—	—	—	—	—
	friend	—	—	√	—	√	—
	narrative	—	—	√	—	√	—
	sensory	√	—	√	—	√	—
	spiritual	—	—	—	—	—	—
Ethics	conservation	—	—	√	√	√	√
	entertainment	√	√	—	—	—	—
	egocentric	√	—	—	—	—	—
	ethnocentric	—	√	√	√	√	√
	moralistic	√	—	√	√	√	√
	utilitarian	—	—	—	—	—	—
History	culture	—	—	—	—	—	—
	direct experience	√	√	√	√	—	√
	global	—	—	—	—	√	√
	local/community	√	—	√	—	√	—
	observation animal	—	√	√	√	√	√
	personal	√	√	—	—	√	√
	social	√	—	√	—	√	√

Table 3.4 John's (Mariner Grade 4) Expressions of Commitment to Environmental Action

		Day 1		Days 2-5		Post-experience	
THEMES	**Subthemes**	Interview	Documents	Interview	Documents	Interview	Documents
Science	ecology	√	—	√	√	√	√
	education		—	√	√	√	√
	physiology	—	—	√	—	√	—
	research	—	—	√	—	√	—
	taxonomy	—	—	—	—	√	—
Aesthetics	art	—	—	√	√	√	√
	drama	—	—	—	—	—	—
	music/song	—	—	—	—	—	—
	narrative	—	—	√	—	√	—
	persuasion	√	—	√	√	√	√
	video/technology	—	—	√	—	√	—
	web-site design	—	—	√	—	√	—
Ethics	conservation	√	—	√	√	√	√
	conservation education	—	—	√	—	√	—
	consumer	—	—	—	—	√	—
History	culture	—	—	—	—	—	—
	global	—	—	—	—	√	—
	local/community	√	√	√	√	√	√
	observation animal	—	√	√	√	√	√
	personal	√	—	√	—	√	—
	social	—	—	√	—	√	—

After recording the table data, I revisited the interview transcripts, documents, and tables to further organize, analyze, and synthesize the data. I re-examined and categorized all the data using three overarching themes to collectively represent the children's environmental knowing: Environmental Knowledge, Ethic of Environmental Care, and Commitment to Action. I used three different highlighters and colour-coded the data to distinguish between the three overarching themes.

As mentioned previously, I kept a research journal for the duration of the study to maintain a record of WaterWorlds events and the children's experiences, and to log contextual details such as names, activities, and the duration and location of events (Hatch, 2002). My journal also included personal perspectives and interpretations of my observations of the children and WaterWorlds activities. I compiled detailed accounts of the children's experiences by documenting their conversations and behaviours and analyzed the resultant data using my five major themes and sub-themes. The observation data helped me establish validity through triangulation with data from the children's interview responses and documents (Denzin, 1989; Krefting, 1990). I also used my research journal to track a chronology of WaterWorlds events.

I wrote a series of vignettes to portray the children's engagement in and response to the WaterWorlds environmental education programme. Miles and Huberman (1994) recommend that the researcher compose vignettes to preserve the chronology of observed experiences and to uncover meaning through description. Vignettes also act as a framework to capture events and "pull together ... rich pockets" (Miles & Huberman, 1994, p.81) of representative and meaningful data to provide understanding over time.

My goal for including vignettes was to portray WaterWorlds events and detail the children's experiences as they participated in programme activities.

I composed the vignettes during my analysis using data compiled during field observations. The vignettes provide structure and focus for my observations, illuminate WaterWorlds field experiences, and create a space for the children's "thoughts and feelings" (Fetterman, 1989, p. 115). As my intention was to provide insight into the WaterWorlds setting, my vignettes include detailed descriptions of activities, conversations, and my perspectives as a programme participant and researcher. In addition to introducing the research setting the vignettes also provide a first look at children's experiences and responses during WaterWorlds events. Thus the vignettes may also be viewed as an introduction to the children's environmental knowing.

Limitations of the Study

Throughout this research study, I made decisions about what to do and when, what data to collect and what to ignore, and what lens to bring to my analyses. Understanding children experiences requires thinking beyond quantitative measures and the acceptance and valuing of interpretive forms of analysis such as investigating their conversations, writings, and drawings. I acknowledge that during the conduct of this type of research, personal bias is inevitable (Glaser, 1992; Janesick, 2004; Strauss & Corbin, 1998). Hence my study's findings reflect my own beliefs and experiences associated with environmental education and the WaterWorlds programme. While I was aware of these influences and recognize this limitation, I endeavoured to make my account of the

children's experiences and the growth in their environmental understanding and commitment as real and as unbiased as possible.

Trustworthiness

Naturalistic research is not intended to provide quantitative results with statistical measures of significance. Rather, in qualitative studies the researcher incorporates specific processes to ensure trustworthiness as a measure of the study's overall reliability and validity. Lincoln and Guba (1985) outline four criteria to enhance trustworthiness in naturalistic qualitative research. They are credibility, transferability, dependability, and confirmability. Credibility establishes that a study is believable to the "critical reader" and approved by those who provided the information (Lincoln & Guba, 1985). In my research, I ensured credibility by employing triangulation of multiple data sources including interviews, field notes, and samples of student work (Denzin & Lincoln, 2000, 2003; Patton, 1990). Interviews were transcribed verbatim, and shared with children during follow up interviews as a form of member checking. I also employed a variety of feedback methods including on-going conversations and probing questions to enable the children to feel comfortable and help them expand on their answers.

Dependability is the consistency of my study's processes over time. I addressed this measure of trustworthiness by conducting three interviews. Confirmability is a measure of what I did, how I conducted the research, and how I arrived at my conclusions (Lincoln & Guba, 1985). To ensure my research process was transparent enough to be understood by others, I kept detailed records of the data collection, coding, and analysis procedures. I asked a colleague who was not involved in the study to act as an

"independent auditor". He reviewed my "audit trail" of interviews, observations, and the children's documents and independently coded some of the data to establish that these materials supported my findings and interpretations.

Transferability refers to the applicability of a study's finding to similar contexts or settings (Lincoln & Guba, 1985; Merriam, 1998). The results of my study may inform other educators or researchers who are interested in children's engagement and response to environmental education field experiences. My research approach and findings may also assist researchers conducting naturalistic studies of similar environmental education programmes conducted in education centres. To achieve transferability, I implemented two strategies recommended by Lincoln and Guba (1985), purposive sampling and thick description narrative. My purposive sampling of four children for in-depth case study analysis provided a range of information about participants' engagement in and response to the programme, and the vignettes of WaterWorlds events presented a rich and detailed account of field experiences and the research setting. These two strategies provide the reader with the in-depth information required to judge whether my study's findings may be relevant to other settings (Erlandson, Harris, Skipper, & Allen, 1993; Lincoln & Guba, 1985).

A possible threat to trustworthiness in an interview based study involving children is respondent or participant bias (Lincoln & Guba, 1985; Patton, 1990). Patton (1990) describes participant bias as a person's perceptions and perspectives which are "subject to distortion due to personal bias, anger, anxiety politics, and lack of awareness" (p.245). In this study, respondent bias may pertain to the children's responses in cases where they told me what they think I wanted to hear to "paint a positive picture" (Bowen, 2005,

p.218) of their experiences. My employment of unobtrusive data collection methods such as reviewing the children's journals and related work provided a "behind the scenes look" (2005, p.57) at their learning and reduced the potential of respondent bias. I also addressed respondent bias by asking similar questions during all three interviews and comparing the answers for consistency.

Ethical Considerations

Throughout the study, I took into account Miles and Huberman's (1994) list of ethical considerations for observational research which includes obtaining informed consent, ensuring there is no harm or risk to participants, establishing honesty and trust between researcher and participant, and guaranteeing privacy, confidentiality, and anonymity.

To ensure my study followed appropriate ethical guidelines, I submitted an application for a Behavioural Ethical Review which was approved by the UBC board in December, 2003 (see Appendix D). As my study involved children, I obtained written informed consent from their parents and/or legal guardians and oral informed consent from the children. I introduced the study to the children during my classroom visit. The children understood that they were not obligated to participate in the study and could withdraw at any time without academic penalty. The classroom teachers also understood that they could remove their class from the study at any time. To ensure anonymity and to maintain privacy and confidentiality, I used pseudonyms for all participants.

My research was also approved by participating school boards, principals, and the marine science centre. To maintain confidentiality and privacy, I used pseudonyms for

the participating schools, school boards as well as for the science centre and the programme.

Reflections on My Roles as Researcher/Participant/Observer

During my second year as a doctoral student, I assumed the position of WaterWorlds coordinator from August 2000 to January 2001. It was due to my encounters with a variety of classes that I chose to investigate children's experiences in this study. Although I was no longer the WaterWorlds coordinator, I conducted this study as both an 'insider' and an 'outsider.' I was a participant and an educator, as well as a former programme facilitator. I strove to find a balance among these multiple roles that would enable me to understand the children's experiences as an insider "while describing the programme for outsiders" (Patton, 1990, p.207).

When I was a "genuine" participant, I spent each day with the children (Atkinson & Hammersley, 1994). I became "socialized" within their group as I actively engaged in all WaterWorlds activities (Schwandt, 2001). Together we studied observation animals, took part in gallery events, attended Expert Talks, and participated in group discussions and presentations. In my role as educator, I facilitated Artefacts discussions, shark talks, the Wet Lab, squid dissections, and the Behind-The-Scenes Tour. As a researcher, I investigated the children's WaterWorlds experiences through observations, interviews, and student documents. These multiple roles enabled me to be "in the world" of each WaterWorlds class and also informed my thinking during data analysis (Atkinson & Hammersley, 1994, p.248).

I collected data on the children's WaterWorlds' experiences through informal and semi-structured interviews, observations, and documents of their work. I was aware that my interpretation of the children's field experiences would be affected by my own engagement in WaterWorlds and my prior experiences with the programme. The children often came to me with biology related questions, asked for my opinion, and sought feedback on their work. I made every attempt to remain neutral when answering questions and to avoid including any personal biases or perspectives in my responses.

To begin my study of each WaterWorlds class, I visited the children in their classroom to explain my study and researcher role. They understood that I was a university student and researcher who would accompany them during programme events to observe and study their experiences. I also informed the children that I was an elementary teacher and a former WaterWorlds coordinator. During the field experiences the children shared their observations, learning, and reflections with me and also regarded me as a resource person.

I found that the children's familiarity with me from the classroom visits helped them feel more comfortable during the field experiences and interviews. Also I believe that my active engagement and participation resulted in the children accepting me as part of their group. I was aware that my presence and the ensuing relationship with the children could distort the "natural scene" of their Water World experiences, but I believe my prolonged engagement and persistent observation of each group overcame any "distortion" of the raw data (Lincoln & Guba, 1985). I also maintained a "critical distance" from the children to ensure that my account and analysis of their experiences was objective as possible (Schwandt, 2001).

Other variables may have affected the children's engagement in and response to the WaterWorlds experiences. The teachers may have influenced the children as it was their decision to participate, and they also developed and implemented various WaterWorlds events. Marine science centre employees also brought their personal biases to the programme. The WaterWorlds coordinator assisted the teachers in preparing for their visits and also created and led many of the field experiences. Centre staff who gave Expert Talks, conducted Behind-the-Scenes Tours, and facilitated gallery activities often selected the theme and delivery method of their presentation.

As a former WaterWorlds coordinator, I 'believed' in the programme. I perceived it as an exemplary environmental education experience. As I did not wish my interpretive bias, environmental beliefs, and personal perceptions about WaterWorlds to affect the children's ideas, I tried to remain neutral during our interactions and cognizant of how both my acknowledged and unseen biases affected the research design and process.

Patton (1990) explains that trustworthiness in qualitative research depends on the skill, sensitivity, and integrity of the researcher. Although I maintained a close relationship with the children throughout my study, I endeavoured through awareness, knowledge, discipline, creativity, and hard work to ensure that my presence did not unduly influence the children's experiences and understanding.

In the next three chapters, I present the results of this research. In Chapter Four, I provide a deep description of WaterWorlds events and the children's response to these events via a series of vignettes. In Chapter Five, I summarize the results of my in depth analysis of children's interviews and documents using an expanded version of Hart,

Jickling, and Kool's (1998, 1999) framework of environmental understandings. In Chapter Six, I focus and elaborate my analysis through the presentation of four cases of children's learning in the WaterWorlds programme and discuss how these cases portray children's environmental knowing.

CHAPTER FOUR

WATERWORLDS VIGNETTES

In this chapter I describe the WaterWorlds Programme and provide an initial description of children's responses to the week's activities. I do this by presenting a series of short vignettes. My goal in composing these vignettes is to provide the reader with a deep understanding of WaterWorlds as a context for examining children's environmental education experiences. The vignettes are structured around a selection of eight different WaterWorlds events that the children participate in during their week-long environmental education programme. I include episodes from WaterWorlds visits by two different schools, the Grade 4 class from Mariner Elementary and the Grade 6 class from Oceanview Elementary, to illustrate the breadth of events that the children experience. Figure 4.1 shows a sample schedule of events for five days spent at WaterWorlds.

The WaterWorlds Programme
Schedule of Events

Time	Monday	Tuesday	Wednesday	Thursday	Friday
Morning 9:00-9:30	ARRIVAL				
9:30-10:30	Animal Observations	Animal Observations	Animal Observations	Animal Observations	Animal Observations
11:00-12:00	Observations Explorations	Drawing Lesson	BTS Tour	Artefacts	Odes
Afternoon 12:00-1:00	LUNCH				
1:00-2:30	Choosing the Observation Animal	Sea Lions	Wet lab	Shark Afternoon	Ode Performances Debrief

Figure 4.1. WaterWorlds Schedule of Events

Vignette 1: First Impressions on Day One

It is the first day for the Grade 4 class from Mariner Elementary, and I await their arrival with Diane, the WaterWorlds programme coordinator, in front of the two-storey waterfront heritage building that is home for this environmental education programme. It is in this spacious well-equipped room located within walking distance of the Centre that the students will start and end each of their programme days. They will also return here for specific activities throughout the week.

Diane and I greet the two Mariner teachers, three parent volunteers, and twenty-seven students as they disembark from the bus. I scan each child's face as we welcome them, and detect eyes wide with expectation and enthusiasm, and in a few cases, slight apprehension. The students enter the classroom and immediately rush to the windows to take in the harbour view. A loud cheer erupts from the assembled group as they observe a great blue heron on the shore below strike and devour a hapless fish. Once the excitement subsides, Diane asks the class to take their seats and introduces herself and the rest of the team that includes three high school work-experience students and parent and teacher volunteers. The children became acquainted with me when I visited their classroom to explain the study and my participant researcher role. Diane keeps the discussion brief because she knows from experience that everyone is eager to begin the day. The teachers ask the children to partner up, and we head outside for the ten-minute walk to the Centre.

Along the way, Diane points to a resident pair of bald eagles that are diligently preparing their massive nest atop an old-growth fir. The children gaze at the soaring silhouettes and voice their astonishment at the bird's immense wingspan and soft staccato

calls. One student describes the bird as "humongous" while another asks, "Is that the sound they make? Too weird!" During our eagle observations, a harbour-bound floatplane passes noisily overhead. From our vantage point, the craft seems to barely skim the eagles' treetop home prompting cries of dismay and concern from the group.

The teachers take advantage of the opportunity to ask the class about the possible effects of the plane's proximity to the birds' eyrie. Some children suggest that the eagle family may be disturbed by the aircraft's cacophonous low-flying approach. When Diane asks what the students could do to help the eagles, they propose sending a class letter to the airline as well as city officials advocating a more eagle-friendly flight plan. The class agrees to return to the nest site each day at lunch to record the number of offending planes and document any behavioural changes in the eagles during the fly-bys.

We resume our trek to the Centre and judging by the children's animated conversations, they are in high spirits as we file through the 'Staff Only' entrance. Once inside, we enter a dark humid gallery filled with the melodious sound of peeping crickets and the guttural croak of amphibian conversation. The children fall silent as we encounter animal care staff tending the inhabitants of a two-storey frog condominium. The class observes from the sidelines as the team of aquarists ensure that each plant is misted and every four-legged resident receives a buffet breakfast of insect treats.

We proceed into the adjacent gallery featuring indigenous marine plants and animals. The children sprint en-masse to an exhibit where an aquarist in full diving gear floats among the fish scrubbing the glass, rearranging marine algae, and examining recent additions. Seeing the captive audience, he places a large seastar against the glass to reveal the invertebrate's opalescent rows of gesticulating tube feet. Some children

respond by emulating the echinoderm's multi-armed anatomy by waving their arms and legs. One student peers closely at the seastar's underside and remarks: "Hey there's its mouth ... you know, like we learned at school, about how it spits out its stomach to eat. I wanna see that." Diane enthusiastically confirms, "You will. Just wait for the Wet Lab!"

From my experiences facilitating the programme, I know that the first WaterWorlds day is reserved for gallery exploration, attending shows and feedings, and choosing an observation animal. Prior to the Mariner students' visit, their teachers discussed possible animal choices with them, but the children's final decision will be made today. The teachers separate everyone into assigned groups of five students and two adults, and we disperse to investigate the galleries, attend beluga and dolphin shows, and observe sea otter and seal feedings.

I spend the next few hours chatting with the students about their observation animal choices. I discover a group of girls in underwater viewing observing the antics of Wings, the Centre's male white-sided dolphin. I solicit their observation animal ideas, and they inform me that Wings is their "number one" choice:

> I'm picking Wings because he's so friendly. (Sue, Mariner Grade 4, conversation, November 24, 2003)
>
> I'm choosing Wings because I like the way he jumps so high. (Donna, Mariner Grade 4, conversation, November 24, 2003)
>
> Wings is so cute. I'm observing him, and I've always loved dolphins. (Jean, Mariner Grade 4, conversation, November 24, 2003)

I go outside to visit the groups gathered by the sea otters, seals, sea lions, and beluga whales. The children tell me they will be choosing one of the marine mammals for observation because they are either "cute", "athletic", "easy to observe", or all of these.

> One thing about belugas, you can always find them. They stick out 'cause they are white ... and big and noisy. (Jill, Mariner Grade 4, conversation, November 24, 2003)

> Sea otters are good to watch 'cause you can see them from above and below for when it's raining. (Trevor, Mariner Grade 4, conversation, November 24, 2003)

When I return inside, I discover the remaining groups gazing rapturously at the sharks and sweating it out in the Amazon gallery in search of the elusive sloths. I ask the students about their observation animal choices, and they reply:

> Sharks 'cause it doesn't rain in here, and it's warm, and I like sharks. (Shawn, Mariner Grade 4, conversation, November 24, 2003)

> I'm choosing something different than sharks ... too many boys [are] at sharks. (Faith, Mariner Grade 4, conversation, November 24, 2003)

During our lunch break, the teachers ask the students to disclose their observation animal choices. When it becomes evident that the dolphin and sharks are overwhelmingly popular, Diane asks if some people would consider switching. Their teachers mention that "it will be too crowded at some exhibits", and many "interesting animals are being left out". Diane then encourages the children to think about indigenous animals, obscure species of fish that are often overlooked, and invertebrates such as crabs and jellies (jellyfish). The teachers remind the students that their final observation animal decision must be made by day's end so "the pressure is on!"

As I conduct my first set of interviews that afternoon with the students, I have the opportunity to ask each child about their observation animal. I spy two of the girls who were originally attracted to dolphins, deep in conversation by the sturgeon exhibit. When I ask about their animal choices, they confirm that although they "love Wings", they feel their dolphin knowledge is already quite extensive:

> I already know quite a bit about dolphins, you know. My family comes here all the time, and I see Wings a lot. (Faith, Mariner Grade 4, interview one, November 24, 2003)

> Wings is cute, but I want to learn about something I don't know much about. (Sharon Mariner Grade 4, interview one, November 24, 2003)

During our conversation, the girls describe the sturgeon as being "awesome" and mention that when speaking with Diane they discovered that "no one knows too much about them, and they really are living dinosaurs!" Sharon reveals that her mother who is with the class as a WaterWorlds parent volunteer encouraged her to choose the enigmatic fish:

> My mom grew up near a river with lots of sturgeon, and she really likes them. They remind her of when she was a girl. (Sharon, Mariner Grade 4, interview one, November 24, 2003)

Faith tells me she chose the sturgeon for its mystery:

> He's kind of scary and mysterious, and also there were too many people at the dolphin. (Faith, Mariner Grade 4, interview one, November 24, 2003)

The girls and I spend the next few minutes observing the sturgeon. Suddenly the fish's massive form emerges from the shadows and speed-swims towards us. Just before reaching the glass, the sturgeon abruptly turns churning the water to create a glittering wall of bubbles. The girls shriek with delight and declare, "He recognizes us and is saying 'hi'. He knows he's our observation animal!"

Continuing my afternoon rounds, I discover another dolphin devotee stationed in the intertidal exhibit. Sarah is inspecting a small tank featuring the delicate and supremely camouflaged bay pipefish. Pipefish are one of my favourite animals so I try to contain my enthusiasm as I enquire about her observation animal choice. She tells me that she "switched from Wings as dolphins are way too popular, but not many people know the pipefish. He really needs me." Sarah adds that although her pipefish knowledge is "not great" she feels he is her "friend already". I am ecstatic that the

inconspicuous bay pipefish has finally achieved the much deserved status of observation animal, and after watching the fish together, Sarah and I enthusiastically share our pipefish musings.

It is 2:30 pm and time to leave the exhibits and return to the classroom. The school bus is waiting in the adjacent parking lot. As we walk back, I hear choruses of, "I am so tired I can hardly walk". Yet when I ask the children about their day they respond, "We can't wait until tomorrow." Before they leave, the teachers and I quickly tally the observation animal choices and confirm five people selected the beluga, four each chose the dolphin, sea otters, and sharks, three picked the sea lion, two each went with the wolf eel, flounder, and sturgeon, and one opted for the pipefish. We agree that this is a promising beginning to our week as the children have chosen an array of observation animals. I too can hardly wait until tomorrow!

Vignette 2: Morning Expert Talk and Drawing Lessons on Day Two

Every WaterWorlds programme features Expert Talks given by Centre staff. The Mariner teachers discussed ideas with Diane during their planning meeting and decided to have the children observe and practice the art of scientific illustration so the expert for their school programme is a professional artist.

Today's Expert Talk is hosted by Dave a head aquarist and talented wildlife artist who will mentor the children through a drawing lesson. Diane introduces Dave and informs us that his duties include caring for animals and also training and managing staff and volunteers, collecting organisms for display and research, and maintaining public displays and reserve areas. Dave is an accomplished scuba diver, and the children learn

he has had "face-to-face encounters" with both the giant Pacific octopus and the elusive six-gill shark.

Dave begins the lesson by showing us his own sketches and paintings. The children declare Dave's work to be "awesome" and ask where "those weird looking fish live". Dave responds that most of the fish species are from local waters, and many can be found in Centre's exhibits.

Throughout the drawing lesson, Dave emphasizes that it is important for fish biologists to possess both a discerning scientific eye and an aesthetic appreciation for their subjects. A significant part of his job is to catalogue newly acquired species and chart their development from egg to adult. He also stresses that accuracy is essential to scientific illustration so every scale must be counted and each fin and individual spine meticulously measured. Dave then demonstrates how to employ a magnifying glass and microscope to detect and record minute details.

For the subject of today's drawing, Dave states that he has selected one of his favourite fish, the Pacific pomfret, a silvery blunt-headed deep-bodied pelagic (open ocean) fish related to the sea breams and fanfish. It will be a "show and follow" lesson with Dave showing the class how to execute a sketch of individual body parts, and the children drawing each part as they follow his instructions. Dave reminds them to "always start with the head and eye, and make sure you leave enough room for the body and fins." He demonstrates where to place the head on the drawing paper and explains that "the head sets the perspective, and the eye provides life and gives the fish personality." The students create an ovoid eye, and as instructed by Dave, leave a white "v" shape within the darkened pupil to indicate a pinpoint of light. They then craft their

fish's head complete with voluminous lips, full puffing cheeks, and a crescent shaped operculum covering the gills. With expert strokes, Dave demonstrates how to execute the fish's body outline and then adds dorsal, pectoral, anal, and caudal fins. He completes the body by pointing out and tracing the fish's "lateral line" from head to tail. When Dave inquires whether anyone knows the function of the lateral line, a hand shoots up and the student states that "it's like a sixth sense so fish can feel things in the water like waves and other fish. Sharks have it big time!" When Dave asks about the source of this "impressive" shark knowledge, the student responds, saying he "learns a lot from the Discovery Channel" and "playing computer games."

The students are now prepared to finish their drawings, and Dave illustrates how to add a hint of scales and colour to complete the composition. The children's piscine portraits are ready for display, and we install "The Gallery of Fishy Characters" (the students' title) along the wall. Over lunch, I overhear many students remark that they will employ their new found drawing expertise during morning observations.

Vignette 3: Up Close and Personal with Sea Lions in the Afternoon on Day Two

During their pre-visit planning meeting, the Oceanview teachers arranged with Diane for the students to go behind the scenes and observe the sea lions. This activity differs from the regularly scheduled indoor behind-the-scenes tour as it involves entering the outdoor research area where off-display marine mammals reside. Only those who work with the marine mammals are usually permitted here, but Diane makes a special arrangement for our group to visit with the sea lions and their trainers.

We file onto the observation deck and are greeted by a vociferous herd of three adolescent Steller sea lions. Diane explains that Stellers do not bark like their more common California cousins. Instead they have a loud throaty growl. They also have a distinctive smell that prompts exclamatory remarks, giggles, and wrinkled noses from our group. The students' comments include, "you can sure smell them before you see them", but the protests subside as four sleek forms flash through the water and pop up onto the deck beside us.

Diane asks the three trainers to lead the activity, and they begin by introducing the "girls". The strong bond between the Stellers and their caretakers is evident as the 200 kilogram animals give each trainer a slippery hug 'hello' and wait patiently for ear rubs. The trainers show us the different hand signals for each exercise and demonstrate how they teach the animals to enter a breathing chamber where their respiration rates and patterns are recorded. After each sea lion successfully enters the chamber and completes a series of tasks, they receive a herring reward and express their thanks with a wet and whiskery 'kiss' for each trainer.

Although the majority of the class appears to be mesmerized by the spectacle, I notice that a few children maintain a safe distance from the boisterous herd. As instructed by the trainers, we keep our hands safely clenched and are careful not to extend any fingers. To emphasize their point, each trainer indicates an assortment of nicks and scars inflicted by over-zealous Stellers. Despite the evidence that there can be painful consequences associated with the job, the children's questions focus on: "How do you become a sea lion trainer?" "How old do you have to be?"; and "What kind of school do you need?"

The trainers then acquaint us with the research study the Centre is sponsoring to help the Steller sea lion. We learn that the Steller's wild populations are declining and scientists are unsure of the cause. The WaterWorlds sea lions are involved in an extensive project investigating their diet, food intake, growth, and metabolism, and the preliminary findings indicate that Stellers are declining due to a change from their traditional herring diet to the less nutritional pollack. The trainers compare the changes to "going from eating steak to a Big Mac". The teachers remind those students observing sea lions to include some discussion of these conservation issues and the Centre's research study in their journals.

Vignette 4: Behind-the-Scenes Tour in the Morning on Day Three

Every WaterWorlds programme features a Behind-The-Scenes Tour where classes view the galleries from the other side. During the tour of the Mariner Elementary children, they observe staff in action, visit administrative areas, examine the workings of pumps and filters, and learn about the Centre's history. The forty-minute event is led by Diane and Centre volunteers.

As volunteers are always at a premium, Diane asks me to guide a group. We start at the shores exhibit where the children can observe some lesser known species that they will also encounter behind the scenes. I begin by asking, "Can you find the fish in this display?" The children peer intently at the small tank and after a few minutes locate the diminutive and sedentary Pacific spiny lumpsuckers clinging to blades of green-bright eelgrass. With some guidance from me, they detect a small suction disc on the fish's underside. When I ask about its purpose, a student replies that, "you can stick on to

something when it's wavy. You won't go anywhere." "So what does that tell us about the fish's home environment?" is my next question. "Definitely around rocks but maybe sand too 'cause it says he likes eelgrass" one student notes as he points to the tank label information.

We then inspect the adjoining display that features the local version of the sea horse. The bay pipefish's reed thin body perfectly mimics the surrounding flora, and it takes a moment for the children to locate its trumpet shaped mouth and gleaming eye. One student describes the fish as "a stretched out seahorse" and informs us with obvious pride that she knows pipefish and seahorses are related as she is studying the seahorse for her observation animal.

Our final stop before heading behind the scenes is the tank containing the Pacific hagfish. When the children read the exhibit information describing the fish's feeding strategies that involve entering their prey (alive or dead) through the animal's mouth or anus, they comment that the process is "gross" and "disgusting". I remind them how Diane responds to these kinds of facts. "Oh yeah", they reply, "not gross but INTERESTING!"

We now head behind the scenes where we encounter scientists and aquarists in charge of research and animal care. The children peer into a darkened tank and encounter an undulating school of immature wolf eels. One of our group who selected the wolf eel as their observation animal tells us that "they sure look different when they get older" and describes his wolf eel as "big, grey, and puffy". A researcher explains that the immature wolf eel's brilliant orange striped colouring changes to a sombre grey in adulthood. He then tells us that Centre scientists breed this local species to augment wild stocks and

supply marine facilities and aquariums worldwide. We move along to observe what the children refer to as "baby tanks" where breeding groups of sea horses, sculpins, and the recently discovered local pandalid shrimp reside. Just before we leave, an aquarist points out a tank where hundreds of tiny transparent bodies ride a circular current. She asks if we can identify the inhabitants. After inspecting the swirling mass, the children reply in unison "baby squid" and explain that they "saw bigger ones in pictures, and you can see these guys have the same kind of bodies and eyes, just smaller." The aquarist mentions that the squid are new arrivals and voices her concern about their survival. "What do you think may be the hardest part about keeping them alive?" she asks. After some discussion and prolonged observation, the children correctly conclude that, "their mouths are so small that you might not be able to feed them."

We then assemble around a small aquarium inhabited by a multitude of small grey bodies that the children identify as the now familiar Pacific lumpsuckers. The fishes' delicate pectoral fins flutter with excitement as the plump females are being wooed by an adoring group of much smaller males. The children peer into the tank "looking for eggs" and note "nothing yet so far." Pipefish occupy a neighbouring tank, and the student who is observing the fish explains how to identify the males. She instructs us to "look at the stomach. If it's sticking out in a bulge, he's pregnant. The males carry the babies you know." I notice that the girls appear delighted with this role reversal as they smile and giggle about "pregnant men" whereas the boys remain unusually quiet.

We then proceed to the reserve areas that house animals that are new arrivals or undergoing medical treatment, involved in research, brooding eggs, or just taking a break from the wet lab or touch pools. An aquarist who has just returned from a "collecting

trip" (diving excursions to collect animals for display and research) challenges the students to determine "who" is in the perforated plastic garbage can floating in the "New Arrivals" tank. One student correctly identifies the inhabitant as an octopus and adds that, "during observations, I heard someone say they are really good at escaping. So I guess you keep them in that garbage can, with the lid on super tight, before they go into their new tank. So they don't escape."

As we continue our tour, the children step onto raised platforms and look down into a series of gallery tanks. They giggle their surprise when an assortment of snouts and fins peeks through the water's surface looking for a meal. We travel through engineering where the children examine the workings of an enormous filter that cleans the entire beluga habitat every ninety minutes and refrigerates the water at the same time. We then enter the marine mammal food room where trainers demonstrate how to "hide" vitamins in herring "so the whales and dolphin don't notice." As we leave, one student comments that she learned during observations that "Wings's favourite food is herring", and "he also has a polka dot tongue"

Our tour is almost over, and just before we join the rest of the class, I challenge the students to select an animal from one of the exhibits and then find it from the "public" side of the glass. After much thought, they carefully choose a subject and then dash about the gallery exclaiming, "Here it is... I found it... come see!"

Vignette 5: An Afternoon in the Wet Lab on Day Three

The Wet Lab is a special classroom that serves as home to marine animals that are resilient enough to be handled by children as well as observed. The lab is part of the

Centre's other school programmes and features open displays housing local intertidal and subtidal (below the tides) organisms ranging from barnacles to brachiopods. During the visit of Oceanview Elementary, we encounter a variety of resident species including an immature giant Pacific octopus, a massive Puget Sound king crab, multi-hued seastars, and a host of hyperactive scallops.

Wet Lab activities begin with an etiquette lesson from Diane who relays the following rules: No feeding the animals, especially one species to another; No use of fresh water as it is deadly to marine dwellers; and No touching except by 'pinkie rule'. Diane explains that rather than poking animals or picking them up by fragile appendages "we can explore and investigate using our gentlest finger, the pinkie, to communicate our caring and respect for the wet lab residents."

The teachers then assign the children to individual tables where an assortment of living creatures belonging to different phyla is displayed. Each table has species from one of the following groups: the echinoderms including seastars, cucumbers, urchins, and sand dollars; the crustaceans such as the Dungeness, Puget Sound King, hermit and kelp crabs as well as barnacles and shrimp; the molluscs represented by chitons, nudibranchs, snails, clams, and the baby octopus; and the cnidarians (formerly classified as coelenterates) which include sea anemones, corals, jellies (jellyfish), and sea pens.

During their planning meeting, the teachers and Diane selected an "exploration and discovery" theme for the Wet Lab. To begin today's activity, they instruct the children to record in their journals any similarities and differences among the animals as well as ideas on "how the animals feed", "the ways they adapt to their environment" and "how they protect themselves from predators". The children spend approximately ten

minutes at each table drawing the animals and jotting down their observations and ideas. Memorable moments include two crusty hermit crabs battling over a coveted home, the sticky grasp of anemone tentacles which confuse fingers for prey, and the crafty moves of the octopus who is christened Houdini by the class as a tribute to his frequent escape attempts.

To conclude the Wet Lab, Diane asks the class to join her at one of the tables where a sea cucumber's elongated form lounges in a large container. She then solicits the students' suggestions for definitions of the words "predator" and "prey". After some negotiation and discussion, the class concludes that "predators eat other things, and the prey is what they eat." Diane then uncovers another container to reveal a multi-armed sunflower seastar. One girl accurately describes the echinoderm as a "cannibal" and a "predator" that "eats everything, even other seastars." When Diane asks about her knowledge of the seastar's aggressive nature, the student replies that, "I read it on the sunflower star tank label."

Diane invites the students to predict what will happen if she puts the two animals together, and their responses include "complete annihilation" and "bloodshed". To test the students' theory, she places the seastar beside the cucumber. Immediately the larger echinoderm's transparent tube feet extend to probe the potential meal. Yet the seemingly helpless cucumber is well prepared. The animal scrunches up its pickle-like body and travels rapidly out of reach using (as Diane later explains) a tube-foot water propulsion system. When the sunflower star resumes the pursuit, Diane tells us to watch carefully. The class cheers as the sunflower star retreats. She explains that the cucumber employs small pincers hidden among the dermal gills and spines called pedicillaria to nip at the

seastar's offending appendages. When Diane solicits conclusions on the predator/prey relationship, one student reports that "based on the cucumber/seastar wars, predators don't always win." After further discussion, the class establishes that "predators usually catch the weak animals or sick or injured ones." Diane then proposes, "Can you think of a predator that only goes for the biggest, healthiest, and tastiest prey?" The children reply in unison, "US!"

The class's Wet Lab experience is not quite finished. The unlucky sunflower star is still searching for a meal, and Diane places a few scallops within tube-foot reach. The scallops immediately fly through the water expertly evading the advancing sunflower seastar. Diane enlightens us on these molluscs' ability to "see" the advancing tube feet that prompts them to "spring into action". The scallops sense the predator's movement through a series of blue eyes located along the mantle at the edge of their shell. The students applaud as the scallops continue to use their muscles to snap their upper and lower shells together and propel their bodies out of harm's way. The seastar is soon outdistanced by the speedy bivalves, and as the students confirm, the prey has "left the building!" Photographs of the Oceanview students in the Wet Lab are included in Appendix C.

Vignette 6: Artefact Investigation in the Morning on Day Four

As part of their WaterWorlds workshop held in the summer, the Mariner teachers engaged in an artefact investigation using the Centre's extensive collection of 'props' which includes jaws from whales, fish, and snakes; skins from caiman, seals, sea otters, and sharks; and skulls from sea turtles, an orca, and piranhas. In the planning meeting

with Diane, the teachers decided to introduce the class to the artefacts through "investigation and inquiry" to enable the children to use their classification knowledge which they studied in class as well as during the Wet Lab. Diane suggests that the activity follow a "teeth, skulls, furs, shells, and skin" theme and the children classify the artefacts through observable characteristics. The children will draw and label each artefact and create an explanation or "theory" for their classification ideas in their journal.

To begin today's activity, the teachers introduce each artefact by asking a series of guiding questions including:

1. Look at the teeth. Are they similar to yours or different?
2. How do you classify animals using their teeth?
3. What might this animal need all this fur for?
4. How does this pelt differ from the other furs?
5. Look carefully at the size and shape of each scale on this skin. Are they all the same or different?
6. What are some ways to classify animals using what we can see?

They then ask the children to draw, label, and classify the artefacts, explain their classification ideas, and choose one "special" object and explain their choice.

Diane and the teachers group the artefacts around the room, and the children then proceed through each station. Using their journals, they record and draw their observations, create a "classification theory", and sketch and describe their "favourite" object. Diane, the teachers, the volunteers, and I visit each station answering questions and providing feedback on the students' work.

I notice that the students linger over the sharp-toothed whale and shark jaws, the velvety soft sea otter pelt, and the opalescent-hued abalone shell. Many choose one of these as their "special" artefact. After the students complete the stations, the teachers encourage them to share their journal entries and "special" artefacts with one another. We then convene as a group, and the students present their work.

A number of students select shells such as the abalone as their "favourite" artefact as they "love the colours" and "the way the inside feels". One of the First Nations children tells us that the fireproof shells are used to burn sweet grass incense which "makes smoke to clean the air and everything else". The children who choose other invertebrates such as the seastar, sand dollar, moon snail, and oyster explain that they "play with them in the summer", "make stuff out of them like wind chimes and decorations", and "paint them" after drying their bodies in the sun.

Diane asks if there are any other "uses" for empty snail and clamshells and suggests the children "think about animals" other than themselves. The class has a pet hermit crab so the students call out in unison "homes for hermit crabs". Diane then inquires about "other kinds of shells" and holds up a barnacle-encrusted oyster shell. The children identify both the oyster and the barnacles, which they refer to as "mini volcanoes" which "really hurt when you step on them." The teachers ask the children to think back to the wet lab where they encountered the living organisms and describe where barnacles live. The students remember that, "they need to live on things like shells and rocks, sometimes even on living animals." Diane then asks how they feel about taking animals and shells from the beach after observing them in the wet lab and learning about them today. Many students state their intention to leave living organisms on the

beach along with "a few shells for hermies" while others comment that they will "still take neat rocks and dead stuff."

The furs are also as a favourite artefact, and I notice that the sea otter pelt is a highlight. Their teachers ask the children what they learned from their in-class assignment on extinct animals, and a discussion follows about the story of the sea otter's near extinction due to the fur trade. One student adds that he did "see some in the kelp when my family went fishing this summer." The fur is passed around and a girl remarks that "You can see why people wanted to wear it", as she drapes the luxurious pelt over her shoulders and strokes the dense chocolate brown fur. Diane reveals that sea otters are "in trouble again" and asks if anyone can find the mammal's favourite food in the artefact collection. The class scrutinizes the objects and after some guiding questions from the teachers, they identify the abalone. Diane explains that both humans and sea otters eat abalone and people who make their living from selling the mollusc are demanding a sea otter cull to increase dwindling stocks. The children are firmly on the side of the sea otter and a number state emphatically that, "They were here first!"

Vignette 7: Shark Afternoon and Dispelling Myths on Day Four

During my tenure as WaterWorlds coordinator, I soon learned that the shark exhibit was one of the most popular displays, and many students, especially boys, chose the shark as their observation animal (staff refer to these keen students as Shark Boys). The teachers at Oceanview Elementary are aware of the children's interest and decide that the class's shark experiences will go beyond the predictable "oohs" and "ahs" of a shark feeding and plan an entire afternoon dedicated to sharks.

Diane asks me to introduce "Shark Afternoon", and I am thrilled to have the opportunity to extol the virtues of another one of my favourite aquatic animals. I believe that WaterWorlds experiences should have an aura of mystery and an element of surprise so I do not disclose the subject of my talk. Instead I tell a story.

I begin by asking the children if any of them enjoy fishing. Many hands are raised, and a discussion of "when?", "where?", "who with?", and "what do you catch?" follows. I then tell the students about my most memorable fish story that took place when I was about their age.

My sister Jill, my best friend Eleanor, and I were fishing fanatics, and we spent our summers casting homemade lines in quest of anything aquatic. Our catch consisted predominantly of shiners and sculpins, but sometimes we hooked dusky sea perch, greenlings, starry flounders, and even the odd Dungeness crab. We never harmed our prey. Instead we placed our captives in a submerged bucket where we gently stroked their slippery bodies, sang to them, counted their fins and scales, and then gently released them.

One summer day we graduated to a store bought salmon rod complete with thirty-pound test line. Confident that this system would yield larger and more unusual specimens, we dropped our line and waited. Just as dusk descended, something grabbed the line, and by the bend of the rod and weight on the line, we knew it was huge. My sister struggled to reel in the quarry while the rest of us yelled advice and instructions. Despite our heroic efforts, the line snapped leaving us all quite deflated but eager for another go. Every evening until the end of summer, we tried our luck. We actually hooked the mystery animal many times but to no avail. Our fishing expeditions ended

with our summer vacation, and we never discovered what was on the other end of that line.

The class has been listening to my story, and it is now their turn to decipher the mystery. Some believe the culprit was an octopus, or perhaps "a giant female ling cod protecting her eggs" or "maybe an old tire." One student proposes, "I think it was a shark ... a really big shark!" I expand upon the suggestion by relaying a conversation I had with a diver who frequented the area where we fished. He was convinced that we had a close encounter with the elusive and deep-water dwelling six-gill shark. These large light-sensitive predators often frequent shallow water in the summer months. The females come close to shore to feed and drop their pups under concealment of the seasonal plankton blooms. We then discuss possible strategies for landing "and then releasing" the two to four metre long, five hundred kilogram fish, and I suspect a few children plan to embark on their own six-gill shark expeditions in the near future.

I then pass two shark jaws and a dried skin around the room while we talk about the children's shark knowledge, experiences, and conservation issues. When I ask, "How many people do you think die from shark attacks in a year?" the answers range from ten to ten thousand. I see looks of amazement when the children hear that the previous year a total of five people perished in shark attacks. One of the shark boys suggests that, "maybe sharks mistake people for fish or seals, you know, like a case of mistaken identity. That's how we look to them." When I ask the class how many sharks they think were killed by humans last year, their answers range from fifty to two hundred. When the students hear that shark-kills by humans are estimated to reach one hundred million each year, they ask, "Who's the predator?"

With sharks on everyone's mind, we head back to the Centre for the afternoon's special event. The students scrutinize the show schedule and discover that there is a shark feeding in ten minutes. I can tell by the animated conversations around me, and the hurried rush to the tropical gallery that the students are excited to observe the sharks in action.

Today the sharks are hungry (they are not always), and we are thoroughly entertained by the feeding. The students do not witness the expected gnashing of teeth and copious amounts of blood but cheer enthusiastically as the sharks expertly take food from the diver's hand. They laugh as the shark's "sneaky" cousin the ray pokes his pointed snout into the food bucket in search of leftovers.

The shark feeding is over, but our shark encounters are not yet complete as we leave the gallery to join our aquarist friend Dave outside the Centre. I notice everyone's eyes widen in anticipation as he explains that they are about to experience an event offered to very few people. As we file up a steep staircase leading to the roof, the children quickly calculate our position and state: "Hey we're on top of the sharks!" We enter the enclosure and traverse a well-secured bridge spanning a pool of turquoise blue water. A quick glance below reveals grey clad snouts and triangular fins swirling along the surface. We have arrived at the shark penthouse!

The class lines up alongside the pool edge as the agile inhabitants, seemingly curious about our presence, circumnavigate the perimeter. Dave demonstrates the metal mesh gloves, dry suit, and breathing apparatus required by the aquarists who feed the sharks "in situ". The children try on the heavy gloves designed to withstand the massive pressure of a shark's bite while Dave dispels any myths the children may have about the

shark's perceived mean temper and vicious nature. He reminds us that this misunderstood fish needs our protection rather than derision as wild populations are diminishing due to over-harvesting, habitat loss, and "just plain fear".

Dave then answers the multitude of questions that focus primarily on his personal experiences swimming with sharks. He concludes by assuring the class that in his opinion the joys of swimming with sharks far outweigh any danger. As we exit the penthouse, I overhear student conversations replete with shark facts, myths, plans to "swim with sharks", and conservation concerns.

Vignette 8: Gallery Activities and Animal Odes on Day Five

Prior to their WaterWorlds visit, the Oceanview teachers planned a series of gallery activities that they co-designed with Diane. Joining the class is a student teacher who is completing an extended practicum. He facilitates a writing activity which the students start on Friday morning and perform that afternoon.

When I learn that the student teacher plans to have each student write an ode, based on their experiences with the observation animal, I am initially sceptical. I feel that the exercise is overly structured and does not follow the WaterWorlds philosophy of exploration and discovery. Keeping my opinion to myself, I eventually warm up to the idea because he is very keen and well prepared.

On Friday morning following their Animal Observations, the children assemble in the Centre's boardroom to begin the ode writing process. When available, the boardroom is used as a classroom due to its convenient location and spectacular underwater view of the Centre's marine mammal exhibits. As we enter the boardroom, the children take a

moment to greet Wings the dolphin who is observing us from his pool and then take their seats around a large rectangular wooden table. The student teacher begins the activity by asking the students to define the word "ode". After much discussion and guidance by all three teachers, the students identify an ode as "a special kind of rhyming poem dedicated to someone who is really great." The next step is a brainstorming session where students list vocabulary words that describe their experiences and feelings about their observation animal. The student teacher hands out the following guidelines to help the students with their word lists:

1. Write some ideas describing why you like your chosen animal.
2. Write some ideas telling interesting facts and unique qualities of your animal.
3. What impacts the life of your animal?
4. Explain why your animal is important to you.

I observe that many children are initially challenged by the task as they sit for some time without writing. The teachers also note the lack of progress and ask the students to refer to their journals and begin with observable characteristics as they did with the artefacts. Diane suggests they include words related to their animal's behaviour and any information they acquired during Expert Talks. "And don't forget how you feel about your animal!" the teachers add.

The children flip through their journals and begin to compile word lists. I glance at their work and note that they start with facts such as their animal's size, colour, and species classification, and then add words and phrases describing their animal's

behaviour, daily routine, and habits. To complete their list, the students write sentences referring to their feelings, emotions, and concern for their animal such as:

> I was pleased by your sparkling eyes. (Angela, Oceanview Grade 6, Ode draft, January 16, 2004)
>
> I love this animal when he turns powerfully. (Owen, Oceanview Grade 6, Ode draft, January 16, 2004)
>
> When people go fishing for tuna there will be less and less dolphins in the world. (Alyssa, Oceanview Grade 6, Ode draft, January 16, 2004)
>
> When I heard your pectoral fin almost came off, my heart almost broke off too. (Denise, Oceanview Grade 6, Ode draft, January 16, 2004)

When we return to the WaterWorlds classroom, the students have completed their final copies and the student teacher asks them to "polish their odes" over lunch in preparation for the afternoon performances.

That afternoon, the children present their odes alongside their observation animal (see Appendix C). One boy reads his "Ode to a Caiman" during the tempestuous accompaniment of an indoor Amazon rainstorm. Wings, the dolphin frolics in the background as another performer praises the animal's "smooth and beautiful skin" and "great jumps" and describes how he "goes through the water energetically". Another student compares the shark's "rough sandpaper skin" to his "father's rough chin". At the conclusion of the performances, the teachers ask the children to reflect on the experience. Many mention they did not particularly enjoy the draft writing part but "loved" performing with their animal by their side.

Researcher Reflections

In writing these vignettes, I endeavoured to portray the multi-disciplinary and multi-sensory nature of WaterWorlds activities and the diverse ways children respond to the programme. As the children engage in field experiences, they forge relationships with science centre staff, teachers, peers, and WaterWorlds animals. Throughout the week, they observe, investigate, draw, write, tell stories, and explore the realm of marine animals and their environment.

These vignettes portray the WaterWorlds programme and also provide the reader with a 'first look' at the children's engagement in and response to specific activities. As the week unfolds the children connect with their 'chosen' animal. Their knowledge grows as they record observations, conduct research, and gather information about aquatic conservation through in-depth study and dialogue. The children come to view marine science centre staff as friends, role models, and mentors. They learn from "the experts" as they practise and hone drawing skills, go behind the scenes with sea lions, visit the shark penthouse, and spend an afternoon with a herpetologist and his amphibian charges. The Wet Lab and Artefact activities encourage hands-on experiential exploration and discovery, and the children draw upon their previous experiences and knowledge to enhance and expand upon new ideas. Gallery activities such as writing and performing the odes encourage the children to reflect upon their week and aid them in interpreting, synthesizing, and expressing their knowledge, care and concern for their observation animal. For the children, these five days of experiences inform and inspire a commitment to help their observation animal, and for some, the ocean environment as a

whole. Photographs of the children during Animal Observations are included in Appendix C.

In the next chapter I present and discuss children's responses to the Water Worlds programme, based on my analysis of interview and document data collected from four classes of students. In Chapter Six I build upon the vignettes in this chapter as I present the cases of four individual children and closely examine their engagement in and response to WaterWorlds experiences.

CHAPTER FIVE

CHILDREN'S ENVIRONMENTAL UNDERSTANDINGS, COMMITMENT TO ACTION, AND ENVIRONMENTAL KNOWING

The next two chapters contain the findings from my study of children's environmental understandings, commitment to action, and their environmental knowing. Chapter Five presents an overview of all 54 children's expressions of environmental understandings and commitment to action. It provides a picture of the range of responses of all children who participated in my study and illustrates how these responses change over time. Chapter Five also sets the scene for Chapter Six, which offers an in-depth look at the experiences of four children and shows how environmental understandings and commitment to action inform environmental knowing.

The findings I present in Chapter Five are based on my analysis of observations, interviews, and documents collected from four classes of elementary students who participated in Water Worlds between October, 2003 and June, 2004. In presenting these results, my intention is to build upon the vignettes provided in Chapter Four and to illustrate more fully how young children understand and interpret their experiences in a marine science environmental education programme. As part of my discussion of findings, I include the two composite data tables that summarize the results of my analysis. The first table (Table 5.1) summarizes the particular environmental understandings expressed in the interview responses and the written and pictorial documents collected from all four classes of children (n = 54) who participated in this study. The second table (Table 5.2) provides a comprehensive look at the children's

expressions of commitment to environmental action emanating from the same set of interviews and documents. In what follows, I discuss my findings and consider how children's experiences in the Water Worlds programme fostered environmental understanding, commitment to action, and environmental knowing.

Table 5.1. Range of Children's Expressions of Environmental Understandings (n=54)

		Day 1		Days 2-5		Post-experience	
THEMES	**Subthemes**	Interview	Documents	Interview	Documents	Interview	Documents
Science	behaviour	12	16	25	32	16	20
	ecology	12	8	31	17	30	18
	education	14	15	27	25	35	26
	naturalistic	28	27	33	33	41	42
	physiology	1	1	15	5	12	5
	research	7	3	14	5	13	10
	taxonomy	17	15	21	10	21	18
Aesthetics	anthropomorphic	19	12	28	27	22	23
	art	12	26	24	44	23	45
	emotions/feelings	19	14	29	25	37	28
	family	2	-	13	-	14	-
	friend	6	-	9	-	9	-
	narrative	2	4	23	15	29	17
	sensory	18	10	27	10	21	9
	spiritual	13	2	22	6	26	6
Ethics	conservation	6	2	29	14	37	33
	entertainment	23	29	10	10	3	8
	egocentric	11	11	8	7	7	5
	ethnocentric	17	10	39	36	42	36
	moralistic	12	7	37	27	39	37
	utilitarian	6	-	12	4	8	-
History	culture	1	1	8	6	7	7
	direct experience	28	32	39	37	35	29
	global	-	4	19	6	30	15
	local/community	4	-	10	2	12	5
	observation animal	1	12	28	35	35	37
	personal	16	20	19	25	18	22
	social	-	3	31	34	37	37

Growth in Environmental Understanding

At the beginning of WaterWorlds the children displayed a range of scientific understandings that related to their pre-programme and initial WaterWorlds activities. Their responses reflected classroom research projects and biological classification (taxonomy) activities and their first-day observations and impressions (naturalistic) of Centre animals:

> Sea lions have ears that stick out ... we studied that, and seals don't. (research, taxonomy) (Sarah, Mariner Grade 4, interview, day one, November, 24, 2003)

> Wings is a dolphin because he's small and a mammal. (research, taxonomy) (Dale, Mariner Grade 4, interview, day one, November 24, 2003)

> Ebi (sea otter) sticks up his feet as he sleeps ... he floats better that way (behaviour, naturalistic) (Lil, Evergreen Grade 5 LN, journal, day one, February 16, 2004)

On days two to five, children's interview and document responses showed additional scientific understandings that concentrated on field experiences, conversations with peers, teachers, and Centre staff, and their direct observations and interactions with WaterWorlds animals:

> Diane showed us how the squid's insides look like ... they have the pen and ink sac. (naturalistic, physiology, taxonomy) (Trevor, Mariner Grade 4, interview, day two, November 25, 2003)

> Ebi (sea otter) keeps a rock in his armpit to crash the shell 'cause he eats the clam. (behaviour, naturalistic, physiology) (Sienna, Mariner Grade 4, journal, day two, November, 25, 2003)

> Sharks move in circles ... and use their tail for swimming ... the bottom tail part helps them swim up. (behaviour, naturalistic, taxonomy) (Harvey, Evergreen Grade 5, LN, journal, day three, February 18, 2004)

Involvement in the programme appeared to foster scientific curiousity and interest as interview data revealed that children supplemented their scientific understandings by reading about center animals and conducting internet searches (research). They incorporated this new knowledge into their scientific understandings:

> I did a search on the computer and learned that they make stuff from sturgeons like lamp oil and glue. (education, research) (Sharon, Mariner Grade 4, interview, day four, November 27, 2003)

> I read and learned (at school) that the arapaima has a fossilized body. (research, education, taxonomy) (Andrew, Evergreen Grade 5 LN, journal, day four, February 19, 2004)

After the programme had concluded, children maintained the range of scientific understandings that they developed through participation in WaterWorlds. However, in their post-experience responses children did not focus as extensively on WaterWorlds events or their interactions with programme personnel, but they continued to reflect on their direct experiences with Centre animals.

Children's aesthetic understandings of the environment also appeared to be augmented through their participation in WaterWorlds. On day one, children concentrated on the appearance of WaterWorlds animals:

> He (Wings the dolphin) has a polka dot tongue. (sensory) (Sam, Evergreen Grade 5 LN, journal, day one, February 16, 2004)

> The mouth (sturgeon) is underneath because it is so sensitive it must be hidden. (sensory) (Faith, Mariner Grade 4, interview, day one, November 24, 2003)

As they spent more time in the programme, children's expression of aesthetic understanding incorporated more emotions, feelings, and reflections. Children's aesthetic responses highlighted the influence of their regular interactions with their observation animal:

> They were cleaning the otters place today and put them in cages. They looked so sad. I wrote 'sorry' on the glass. (anthropomorphic emotions) (Rachel, Mariner Grade 4, interview, day five, November 28, 2003)

> As soon as my animal saw me in the morning, he would speed swim by and wave hello. He knew me! (anthropomorphic, emotions) (Richard, Evergreen Grade 5 LN, programme evaluation, day five, February 20, 2004)

> I liked having a connection with my seahorse ... It was priceless. (emotions, spiritual) (Claire, Oceanview Grade 6, interview, day five, January 16, 2004)

Children maintained these aesthetic connections and understandings post experience although some of their responses focused less on specific events and more on memories of and reflections on the week:

> I love all the animals in the world even disgusting and ugly animals. I would never do anything to harm them. (art, emotions, sensory) (Jennifer, Evergreen Grade 5 LN, interview, post-experience, May 27, 2004)

> I feel that I didn't want to leave WaterWorlds because I wanted to learn more about the environment. It was awesome! (emotions, spiritual) (Rosie, Mariner Grade 4, thank you letter, post experience, February 25, 2004)

> I never even knew that I would relate to the pipefish that well. Some people just didn't understand how I felt about the pipefish. I mean you've been there for the whole week, and you've seen them, and sometimes you feel like they are your family. We are connected like best friends and soul mates. (emotions, family, friend, sensory, spiritual) (Sarah, Mariner Grade 4, interview, post-experience, February 12, 2004)

Children's initial ethical understandings of the environment were largely human-centered. Most children arrived at WaterWorlds with egocentric ideas about the marine environment and its inhabitants. Children's conversations and documents at the start of the programme reflected this focus as their responses highlighted the shows and feedings they attended on the first day of their field experiences, and how excited they were by the entertainment aspect of WaterWorlds animals:

> Wings jumps so high. I like his tricks! (entertainment) (Tisha, Mariner Grade 4, journal, day one, November 24, 2003)
>
> See, they're (sea otters) dancing for us! (egocentric, entertainment) (Seth, Evergreen Grade 6 LN, interview, day one, February 23, 2004)

As the children engaged in WaterWorlds experiences they developed a more nature-centred (ethnocentric), conservation-focused understanding. The data from days two to five and post-experience reveal that the children concentrated less on 'showmanship' and became concerned about the welfare and survival of marine organisms at the Centre and conservation of the ocean environment as a whole:

> Wings looks sad. He needs a mate... It's only fair! (ethnocentric, moralistic) (Tia, Evergreen Grade 7 LN, journal, day two, February 24, 2004)
>
> Sharks need help because people kill them too much, and it's not good for them, and it's not right. (conservation, ethnocentric, moralistic) (Will, Evergreen Grade 5 LN, journal, day four, February 19, 2004)
>
> When Wings gets caught in fishing nets ... instead of tuna ...there will be way less dolphins in the world, and that's not good for anybody or dolphins. (conservation, ethnocentric, moralistic) (Shawn, Mariner Grade 4, research project, post-experience, February 12, 2004)

All but five children said they would not eat their animal "even if they were starving" (ethnocentric) because they "loved" their animal, wanted to "make sure they lived to have babies" (conservation, ethnocentric), and "they have a right to live too" (conservation, moralistic). In contrast to this conservationist perspective there were the utilitarian responses of a small number of children, who did not alter their views over the course of programme experiences. These children focused on the economic value of nature and thought about marine animals in terms of food or pets. For some children, a utilitarian response could be attributed to their cultural beliefs:

> Shark fin soup costs a lot of money so my shark would be expensive. (egocentric, utilitarian) (Robbie, Evergreen Grade 5 LN, interview, day one, February 16, 2004)
>
> I want to take my jelly home for a pet. (egocentric, utilitarian) (Melissa, Mariner Grade 4, interview, day five, November, 28, 2003)

The number of children with historical understandings of environment also increased over the course of the programme, and these understandings were evident in children's verbal responses and written work after the programme had ended. Gains in historical connections with the marine environment appeared as children learned about the ocean realm that existed beyond the WaterWorlds setting during events such as Expert Talks, the Wet Lab, and Artefacts activity:

> They (sea otters) swallow oil that people dump, and it makes them sick and pops the bubbles in their fur. (social) (Pam, Mariner Grade 4, interview, day four, November 27, 2003)
>
> Propeller blades from big ships, you know, freighters from Japan, hurt jellies. (global, social) (Tracy, Mariner Grade 4, interview, day five, November 28, 2003)
>
> They blow up the reefs in some countries to get the fish to sell for money and for like pet stores here. (local, global, social) (Vivienne, Oceanview, Grade 6, programme evaluation, day five, January 16, 2004)

The understanding of global environmental issues reflected in Pam, Tracey, and Vivienne's responses extended beyond the Water Worlds week. Interview responses by 30 of the 54 children and written work produced by 9 children after the programme had ended dealt with issues concerning the ocean environment as a whole.

The children's development of a historical perspective regarding the environment appeared to be closely related to the bond they developed over time with their observation animal. My data indicates that many children began to view WaterWorlds

animals as peers and companions: "Our animals are part of our class now. We've been with them every day. I wish they could visit us after we leave" (direct experience, observation animal, personal) (Daniel, Mariner Grade 4, journal, day four, November 27, 2003). Over the course of the programme children's work and words showed an increasing focus on the lives and experiences of WaterWorlds animals:

> Wing's story is that he came from Japan and flew here in a plane. He didn't know how to jump when he got here but he's the expert now! (global, observation animal) (Neil, Evergreen Grade 5 LN, interview, day three, February 20, 2004)

> Watching the belugas reunite was the best ... the dad and auntie have been away for a while. I don't know how I would feel if my dad had been away for a whole year! (observation animal, personal) (Jess, Oceanview Grade 6, interview, day four, January 15, 2004)

A number of children's responses reflected how they identified with their observation animal, as they spoke and wrote about cultural, social, and personal experiences they felt they shared with their aquatic companion. Claire's journal provides an illustration of this: "I felt just like my seahorse on my first day at a new school. I didn't have any friends so I put my head down just like he did" (direct experience, personal) (Claire, Oceanview Grade 6, journal story, day four, January 15, 2004).

In summary, my analysis suggests that children gained environmental understandings in Science, Aesthetics, Ethics, and History through participation in WaterWorlds, and that they maintained these understandings after the programme ended. Over the course of the week, children placed less emphasis on shows and feedings and focused more on interactions, conversations, and learning from field experiences. There was evidence that the children who took part in WaterWorlds became more aware of, interested in, knowledgeable of, and emotionally connected to the lives and wellbeing of

marine organisms. By the end of the programme, they focused less on 'what can nature do for me?' and developed a more global and intrinsic view of the natural world.

Table 5.1 illustrates the breadth of responses and diverse ways in which children in the Water Worlds Programme expressed their environmental understanding. The table also illustrates the ways in which the children's responses to the programme changed over time, and the ways that that children augmented and extended their expression of environmental understanding through their participation in WaterWorlds.

Commitment to Environmental Action

The focus and range of children's expressions of environmental action varied considerably over the course of the programme (see Table 5.2). Initially a small number of children were able to articulate any views about action. Children's understanding of action grew and their expressions of commitment to action for the environment became more varied, as they learned about the various environmental issues that impacted the marine ecosystems and its inhabitants. By midweek children were developing ideas about how they might help their observation animal, and at the end of the programme and post-experience more than half the children had well articulated action plans.

Table 5.2. Range of Children's Expressions of Commitment to Environmental Action (n=54)

		Day 1		Days 2-5		Post-experience	
THEMES	**Subthemes**	Interview	Documents	Interview	Documents	Interview	Documents
Science	ecology	5	4	22	23	32	37
	education	5	4	25	26	42	27
	physiology	-	-	4	7	8	5
	research	4	-	20	-	20	-
	taxonomy	-	-	4	-	8	-
Aesthetics	art	3	2	23	19	33	25
	drama	-	-	4	-	10	-
	music/song	-	-	-	-	4	-
	narrative	2	-	16	-	35	-
	persuasion	1	1	23	14	40	19
	video/technology	-	-	4	-	21	-
	web-site design	-	-	4	-	19	-
Ethics	conservation	4	7	29	18	38	22
	conservation education	1	5	28	20	42	23
	consumer	-	-	11	3	17	9
History	culture	2	-	2	-	6	-
	global	-	4	14	6	25	9
	local/community	2	-	9	4	14	8
	observation animal	-	9	19	15	43	21
	personal	-	-	11	-	20	-
	social	-	-	5	8	26	15

Interviews and the WaterWorlds programme evaluation provided the richest source of data on children's commitment to action. During each interview, I investigated the children's commitment to environmental action by asking how they would "help" WaterWorlds animals. The evaluation, completed on the last day of the WaterWorlds programme, prompted children to share their ideas about environmental actions and included the question, "What are you going to do in your life to protect the ocean?" The range of responses elicited by these two questions is shown in the Table 2 data for days two to day five. Given that some children wrote and spoke about their commitment to action on occasions when they were not responding to direct questioning, it is possible that the interview and programme evaluation questions served as catalysts that prompted children to reflect upon and develop environmental action plans to help their observation animal and, for some, inspired commitment to action for the marine environment as a whole.

My analysis of children's expressions of environmental action indicates some trends. Most children's expression of environmental actions reflected their growing connection with WaterWorlds animals. I found that the children's observation animals were the focus of the action plans they described during interviews and in written work:

> In my video I'm having a conversation with my animal Ebi (sea otter), and we would talk about how he was abandoned and ... found floating and what his life is like now. (narrative, video/technology, conservation, observation animal, personal, social) (Tim, Evergreen Grade 7 LN, interview, day four, February 27, 2004)

> Tanu's food is running out and he's eating hamburger fish instead of steak so we need to tell people about it and to stop catching herring. (physiology, ecology, conservation education, persuasion, observation animal) (Cindy, Mariner Grade 4, programme evaluation, day five, November 28, 2003)

The children's plans for environmental actions initially focused on helping their observation animal by improving its living conditions at the Centre such as cleaner water for the belugas and finding Wings the dolphin a mate. Over time, children were influenced by, and increasingly incorporated, ideas from their WaterWorlds activities. Thus their plans at the end of the programme included strategies such as teaching and learning (education) about the marine environment, writing (narrative) and illustrating (art) stories in journals, and collecting data through observation and study (research):

> My book on Tanu would have sea lion information and my own drawings and stories and a table of contents. (research, art, narrative, observation animal) (Nikki, Mariner Grade 4, interview, day five, November 28, 2003)

> I would write and illustrate a book teaching about dolphin facts and my studies on how they (dolphins) help us. (education, research, art, narrative) (Jill, Evergreen Grade 6 LN, interview, post-experience, March 5, 2004)

Victor (Mariner Grade 4) planned to compose a rap song based on his observation animal experiences and wanted to "make a CD so everyone will hear about my wolf eel" (music/song) (interview, post-experience, February 11, 2004). Oliver's proposed environmental action included a detailed narrative on sharks:

> My story is like the one in my journal. It would tell about a guy who takes a pregnant shark and puts it in an aquarium .... to have babies, and then in the real sea, all the shark of that type are extinct. And then without that shark, because the shark is like a scavenger, there is lots of waste in the sea. Then people would see that the shark is a good thing. (taxonomy, narrative, persuasion, conservation, conservation education, global) (Oliver, Oceanview Grade 6, interview, day five, January 16, 2004)

Another notable trend was the children's inclusion of technology and e-learning in their action plans post-experience. Their ideas reflected current and prevalent developments in education and communication that the children were experiencing in their lives:

> I would create a website and call it jelly dot com like on my (computer) favourites! (website design, personal) (Jess, Mariner Grade 4, interview, day three, November 26, 2003)

> I would do a movie with my underwater camera so people could see for themselves how belugas are dying and the coral reef too. (video/technology, persuasion, conservation, global) (Bill, Evergreen Grade 5 LN, interview, day four, February 19, 2004)

> [I would like ...] to go scuba diving to see how the world is and get people to film me like on TV talking about it so they know how I feel about beluga whales. (video/technology, conservation education, global) (Devon, Evergreen Grade 6 LN, interview, day five, February 27, 2004)

Jack, a Mariner Grade 4, student intended to create a website "on everything about the flounder" as during his computer searches the only information he was able to find about his observation animal concerned "recipes on how to cook it" (interview, post-experience, February 13, 2004). Tessa (Mariner Grade 4) spoke of incorporating e-learning and technology into her action plan: "I would create a video on the sea lion in the food chain and put it on the Internet on my own website" (video/technology, website design) (interview, post-experience, February 12, 2004). Some children's expressions of environmental action addressed animals in captivity even thought this issue is not discussed by center staff or included in WaterWorlds activities. For example, Sarah wrote: "I would put all the fish living here back in the ocean" (ecology, observation animal) (Mariner Grade 4, journal, day three, November 26, 2003). Seth's proposed action focused on the harvesting of animals for public display:

> I would tell all about the zebra moray, and how we shouldn't make take them for aquariums, and I would show how we wreck their coral reef homes and take them away from their families when catching them. (narrative, persuasion, conservation, social) (Seth, Evergreen Grade 6 LN, interview, post-experience, May 27, 2004)

The children's focus on and concern for the captive animals in the marine science centre illustrates that even young children are aware of the ethical issues associated with keeping animals in zoos and aquaria. Marine Science Centre staff may need to incorporate some discussion around the rationale and justification for keeping animals in captivity so that children can be fully informed and make their own decisions on this issue.

On day one, a small number of children included education and conservation-based actions in their plans, but by mid week to day five and post-experience there were higher numbers and a broader range of conservation and education oriented activities being proposed:

> I would never wear fur from Ebi. I don't want him to die and also, he needs fur to keep warm. I would tell people about that so they helped him live too. (conservation, conservation education, observation animal) (Pia, Evergreen Grade 5 LN, interview, day five, February 20, 2004)

> I'm going to teach people that they should protect the ocean and not to litter, but instead they could protect the ocean so that animals could live and survive. (conservation, conservation education, social, global) (Sean, Evergreen Grade 7 LN, programme evaluation, day five, February 27, 2004)

This trend is not surprising as it reflects the messages and lessons provided for children through the Water Worlds experiences. What may be more significant is the number of children who continued to speak or write about participating in conservation activities after the programme had concluded:

> I will not eat the important sea stuff that we need. I'm going to protect the ocean by not putting oil or drinks on the ocean because that is where sea animals' habitat is. I will be protecting and taking care of them. (conservation, global, social) (Daniel, Mariner Grade 4, interview, post-experience, February 12, 2004)

Over the week, an obvious trend was the increase in the children's commitment to environmental action on a global scale. When sharing their ideas on environmental action, children initially focused on WaterWorlds animals:

> The belugas need a cleaner home. The water is dirty. (observation animal) (Ashley, Oceanview Grade 6, journal, day two, January 13, 2004)

> Wings needs to get a mate so they can have babies ... then they (the Centre) can release the babies so there are more wild dolphins. (local/community, observation animal, global) (Tessa, Mariner Grade 4, journal, day two, November 25, 2003)

Toward the end of WaterWorlds and post experience children voiced and wrote about commitment to action that benefited all marine species and the ocean environment worldwide:

> Help sharks by not fishing them too much. They need our help because they are good for the ocean. (social, global) (James, Oceanview Grade 6, programme evaluation, day five, January 16, 2004)

Jennifer provided the following description of how her proposed action would benefit ocean animals world wide:

> I would create a poster and I would put them all around the world because it's really not fair to the belugas. They need our help and health. They are getting sick. The people who are beluga lovers, they won't get to love the belugas. This could lead to beluga extinction. It's not fair for us and for the killer whales and polar bears and the humans because everybody needs their food. If there is an extinction chances are killer whales won't have any other food to eat, and they are going to lead to extinction. Polar bears might... and it's all connected. But humans have different things to eat. If all of the fish will get taken, then the fish will get extinct all over the world. (ecology, physiology, art, conservation, global, social) (Jennifer, Evergreen Grade 5 LN, interview, post-experience, May 27, 2004)

These clearly articulated views about global actions suggest that the WaterWorlds experiences such as Expert Talks, the Wet Lab, Artefacts, and the Behind-the-Scenes Tour that incorporated information about conservation and conservation education in

local and global contexts helped the children learn to express themselves and aided them in developing their personal vision for environmental action.

The stability of the children's commitment to environmental action after their field experiences may be attributed to the continuation of WaterWorlds and conservation themed activities after the programme ended. The Oceanview class created WaterWorlds-inspired fish sculptures. The Evergreen children documented environmental education experiences such as field trips to local parks in their WaterWorlds journals; both Evergreen LN classes worked together to create a fabric mural depicting their observation animals (see Appendix C). The Mariner children completed research projects, created murals, wrote stories and poems, composed songs, and acted in a play dedicated to their observation animals. They invited WaterWorlds staff, fellow students, and their teachers and family to a celebration featuring WaterWorlds themed activities.

In summary, my data analysis indicates that children who participated in WaterWorlds and this study acquired a diverse range of environmental understandings and an enhanced capacity to articulate their ideas for environmental action. At the start of the programme, children were comfortable and capable of sharing their understandings of environment but had little to say about environmental advocacy or actions. This changed over the course of the week, and by the close of the programme children could articulate a personal environmental advocacy and action plan. The interview and document data also provided evidence that the Water World experience contributed to children forming strong emotional bonds with the aquatic animal they observed, and for

some children the programme appeared to foster a deep concern for the global marine environment that continued after the programme ended.

These trends were apparent in the data from all four classes of students that took part in this study (see Appendix B). I did, however, notice some differences in how the three school groups responded to particular elements of the Water World programme and in their willingness to engage with me about their experiences. The Grade 4 class from Mariner Elementary showed the greatest diversity of environmental understandings and actions in their document and interview responses over time. These children were always willing to discuss their WaterWorlds experiences with me, and all 28 Grade 4 students from Mariner voluntarily participated in all three interviews and provided numerous samples of their WaterWorlds journal, documents, and related work (see Appendix C). The children's enthusiasm for the marine environment continued well beyond the weeklong programme. Mariner Elementary students' continuing interest in, and dedication to WaterWorlds, was further demonstrated through their organization of a school-wide WaterWorlds celebration. Children composed songs, wrote and performed a play about ocean communities, published a WaterWorlds newspaper, and hosted aquatic-themed games and artefact demonstrations. A parent volunteer filmed the week of events and produced a video documenting the children's experiences.

The fact that children in Mariner Elementary had participated in extensive preparation prior to attending the WaterWorlds programme was likely a factor that contributed significantly to the level of appreciation and enthusiasm for the programme evident among these students. Still, my experience with the Mariner class lends support to research that claims children between the ages of 6 and 12 children are keenly

interested in learning about their relationship with the natural world and concerned about the deleterious effects humans have on the environment (Kellert, 2002; Regeski, 1982; Sobel, 1995, 1996).

The Grade 6 children from Oceanview school made smaller gains and showed less diversity in their environmental understandings and actions than the Mariner Elementary Grade 4 students. I observed that during their field experiences, Oceanview students appeared to be less engaged than the younger participants. They were not as talkative or as willing to share their WaterWorlds experiences; only eight of the 27 students participated in all three interviews. Yet their written work showed detailed accounts of their experiences illustrated through short stories, poetry, research reports, and in-depth observation, study, and reflection. My observations also suggest that with older children, non-verbal modes of expression may be a better way of accessing environmental understandings and commitment to action. The level of response by some of the Oceanview Grade 6 students to Water Worlds supports the findings of educational researchers who state that "programmed" environmental education experiences such as WaterWorlds may be best suited to younger children (Sobel, 1993; Kellert, 2002).

The Language Needs students from Evergreen school made their greatest gains in both number and diversity of environmental understandings and expressions of commitment to environmental action after their field experiences concluded. Their teacher indicated that these students "had lots to say" but required some "percolation time" for experiences to "sink in". At the end of their week and after WaterWorlds concluded, I observed that the LN children were more talkative and willing to share their experiences with me than they were during the first days of the programme

Closing Thoughts

My analysis of the data suggest that children's engagement in Animal Observations, Expert Talks, Artefacts, and gallery activities such as writing and performing odes informed their environmental knowing. Children gained knowledge of marine species and ecosystems, connected with WaterWorlds animals, cultivated feelings of empathy, care, and concern, and created ideas about ways to help ocean inhabitants and their communities. These findings support educational researchers and practitioners who claim that experiential environmental education has a positive effect on children's environmental attitudes (Chawla, 1999; Manfredo, Teel, & Bright, 2003; Palmer 1993, Palmer, Suggate, Robottom, & Hart, 1999). During my analysis of the children's responses, I identified two factors that may have informed, enhanced, and augmented the children's WaterWorlds experiences and contributed to the growth in their environmental understandings and commitment to environmental action. One factor is directly related to the design of the WaterWorlds programme. The other is related to the current passion for visual media in our culture.

Environmental thinkers and educators state that being in the company of informed adults influences children's environmental views and behaviour (Carson, 1965; Hart, 1997; Van Velsor, 2004) as does their socio-cultural background, previous knowledge, and life experiences (Chawla 1999; Gruenewald, 2005; Hansen & Van Fleet, 2003). These elements appeared to play powerful roles in the WaterWorlds programme. While most of the participating children began WaterWorlds with environmental understandings and some advocacy ideas, children drew upon personal and prior experiences with their family, culture, and community as they refined and augmented their environmental

understandings and action goals. This illustrates the significance of prior experiences and background on children's environmental thinking and knowing. Further, classes at WaterWorlds engaged in events alongside committed and informed adults. The teachers, parents, volunteers, and WaterWorlds staff who accompanied each class served as guides, mentors and role models as they facilitated and inspired the children's engagement in and response to programme events.

My analysis of children's verbal and written responses indicated that current media or 'pop culture' may have influenced the children's environmental understandings and action goals. At the time this study was being conducted, the animated film Finding Nemo (2003) was popular, and many children referred to the movie's characters of damselfish, sharks, jellies, and hermit crabs when they spoke and wrote about WaterWorlds. The children also mentioned television programmes, computer games, websites, and books as additional sources of information. The incorporation of these different learning tools in their responses supports claims that a relationship exists between media and children's environmental attitudes (Bousé, 2003; Corcoran, 1999; Champ, 2002; DeRuiter, & Donnely, 2002; Eagles & Demare, 1999).

In this chapter I discussed my analysis of the children's responses to the WaterWorlds programme as seen in the interview and document responses from all participants. To provide an in-depth look at individual children's engagement in the week's events and the ways programme experiences inform environmental knowing I now present four children's WaterWorlds stories.

CHAPTER SIX

FOUR CHILDREN'S STORIES

In this chapter, I develop four individual stories of the children's experiences and explore the impact the WaterWorlds programme had on their environmental knowing. I look in-depth at two girls and two boys, describe the different histories they bring to the programme, and examine the ways the programme influenced their environmental knowing. I conclude with a discussion that draws the four individual cases together and consider how the experiences in and features of the WaterWorlds programme fostered environmental knowing.

Claire's Story

Claire is eleven years old and in Grade 6 at Oceanview Elementary. She lives with her father on the local First Nations reserve. Claire first enrolled at Oceanview Elementary in September and thus is new to both the school and the neighbourhood.

When I speak with Claire before she begins her first day at the Marine Science Centre, she tells me she is not looking forward to the programme and does not believe she "will learn anything". She refers to most of the animals as "dumb" and "stupid" and characterizes some as "boring ... because they don't move much" and "have no brains" (conversation, January 12, 2004). Claire's initial response to the programme is not typical. When I speak with her classmates, almost every student expresses excitement and enthusiasm about the week ahead. Claire's comments pique my curiousity, and I am interested in observing and conversing with her further. My decision to study Claire is

encouraged by one of her teachers who urges me to "Keep an eye on Claire. She is one to watch" (Karen, Grade 6 teacher, Oceanview, conversation, January 12, 2004).

Claire's Experiences

Claire's **first day** includes an observation animal search, beluga and dolphin shows, seal, sea lion, and sea otter feedings, and 'free time' in the afternoon for individual exploration. I ask her about prospective observation animals, and she acknowledges that she likes dolphins but wishes to choose a different animal because she "knows everything about dolphins already" (conversation, January 12, 2004). I spend the morning observing Claire, Amanda and Rosie, girls from her class who are her "two best friends". As they tour the galleries searching for observation animals, Claire assumes the role of 'teacher' to Amanda and Rosie but does not converse with other classmates or Centre staff. As the three girls visit various exhibits, Claire imparts information on potential observation animals:

> That is a sea urchin. You see the spines? Doesn't move much so not a great observation animal.
>
> There's a lion fish. Step on that and you're dead!
>
> Those little fish there, they live in the anemone. Nobody else can do that 'cause they sting.
> (Claire, Grade 6, conversation, January 12, 2004)

When Claire encounters unfamiliar organisms, she reads the tank label to herself and then relays the newly acquired facts out loud to her two friends:

> The babies (butterfly fish) have different colours than the parents. They change when they grow up.
>
> (Moray) eels grow up to one metre long.

Sea turtles can live maybe a hundred years or more.

Those are black-tipped reef sharks, and that's their cousin the ray.
(Claire, Grade 6, conversation, January 12, 2004)

Claire enjoys the attention from her two companions and becomes more animated as her friends listen intently to her 'lessons'.

After a busy morning, I notice that most of the students spend the 'free time' after lunch with their newly selected observation animal. I spy Claire beside a small exhibit in the tropical gallery. When I inquire about her observation animal, she points to a delicate form floating above the coral reef landscape. She informs me she chose this unique animal for his "lonely look" and "extremely cute" countenance and christens him "Vinegar" due to the seahorse's pale hue. She also mentions that she "wants to learn more" about seahorses and is "excited" about "getting to know Vinegar tomorrow" (interview, January 12, 2004).

On **Tuesday** the students' schedule begins with one hour of Animal Observations followed by the Artefacts activity and then an Expert Talk with the sea lion trainers in the afternoon. I visit Claire in the morning for Animal Observations as she compiles detailed notes on seahorses in her journal. Her writing focuses on information synthesized from her previous knowledge, gallery labels, and fact sheets supplied that morning by Diane the programme coordinator. When I ask about her writings she tells me that she read about seahorses in "books about ocean animals" but is surprised to learn they are fish. To confirm her findings, she indicates a pair of fluttering pectoral fins which she "discovered" while counting the rhythmic puffing of the fish's operculum which Claire states is "the scientist's word for gill flap" (conversation, January 13, 2004). Claire then tells me about Vinegar's physiology, life history, and geographical distribution and

reveals that the "coolest" seahorse fact concerns the fish's parental duties. She appears excited as she describes the role reversal unique to seahorses and their pipefish cousins where the male broods the eggs and "takes care of the babies". During the last few minutes of her observation, she carefully sketches Vinegar's sinewy shape and adds the "small brood pouch" which denotes his gender. "I just noticed that today!" she adds (conversation, January 13, 2004).

For the Artefacts activity Claire's two teachers organize three stations and instruct the students to select "one favourite artefact" from each station and closely observe it to "look for patterns in nature". The children then cycle through a rubbing station (which involves placing a piece of paper over an object and 'rubbing' with a charcoal crayon), a drawing station, and a writing station and record their efforts on a worksheet. Claire rubs the patterns of a caiman skin (species of crocodile), draws the rotund body of a puffer fish, and writes about the sea otter pelt. She also includes personal reflections on the artefact activity in her journal such as, "I saw sea otters wrapped in kelp when we went fishing last summer", "Puffer fish look crazy and their spines hurt!", and "The caiman skin reminds me of my Vinegar" (journal, January 13, 2004).

The Expert Talk with the trainers of the four Steller sea lions takes place outside in a training pool that is not open to Centre visitors. Claire is quiet throughout this session and seems content to assume an observer role. She listens intently as the trainers introduce the four sea lions and then explain their jobs and the research study being conducted on feeding behaviours and respiration rates. I notice that Claire smiles and laughs along with her classmates as the energetic mammals 'hug' and 'kiss' their trainers. She also heeds the trainers' warning and keeps a safe distance from the boisterous

animals with her hands safely clenched at her side. As we leave the sea lion enclosure and head back to the WaterWorlds classroom I ask Claire about the experience, and she replies:

> That was pretty cool. I would like to do that, train and study sea lions and then tell people about it and help the sea lions survive. (Claire, Grade 6, conversation, January 13, 2004)

On **Wednesday** morning, Claire continues her Animal Observations and participates in the Behind-The-Scenes tour (BTS), and then takes part in the Wet Lab in the afternoon. During her observations Claire focuses on her "new friend Vinegar's" health and well-being and observes that he appears slower and more timid than the other seahorses. She tells me her concern that her seahorse's translucent armour, a hue she observes that seems to be unique to Vinegar, may indicate that "he is not feeling well" (interview, January 14, 2004). To gain a better understanding of Vinegar's behaviour and physical appearance, Claire interviews the aquarist responsible for his care. After their chat, Claire appears relieved as she tells me that Vinegar is thriving. She explains that seahorses are naturally timid with some being more reclusive than others. She also learned that Vinegar's delicate colouring indicates his "expertness" in the art of camouflage. He can, not only assume the colour of his environment, but also shape his body to mimic the twisting topography of his coral home. Claire records the interview specifics in her journal and sketches Vinegar's colouring, swimming patterns, and resting behaviour. Throughout the day, she makes three additional trips to the tropical reef gallery to "check" on Vinegar "just in case" he is "feeling sick" (interview, January 14, 2004).

The BTS tour takes place before lunch. During the tour, the children observe the areas of the Centre not accessible to visitors. They watch and speak with Centre staff as they work, and observe Centre animals that are not on display. Diane has asked me to lead a group of five children which serendipitously includes Claire. We begin at the Shores exhibit, where in response to my questions about the local species of pipefish, Claire tells us that the fish is a "cousin" to her seahorse Vinegar. When we visit the research area that houses breeding pipefish, she fills us in on the male's parental role that includes incubating the eggs and rearing the fry. Throughout the tour, Claire is the only one to ask questions including "How do you catch lionfish? ", "How do you feed baby jellies (jellyfish)?" and "Where did you learn to do this?" She then tells the aquarists that she is "thinking about being a marine biologist" so she can work with animals (conversation, January 14, 2004).

The Wet Lab takes place after lunch in a classroom featuring living local invertebrate species found in both rocky and sandy intertidal environments. The children are encouraged to handle the lab residents which are housed in a series of open tanks along the classroom walls and displayed in containers grouped on four tables in the centre of the room. The teachers ask the class to visit the different tanks and tables and record in their journals similarities and differences among the animals as well as their ideas on "how the animals feed", "the ways they adapt to their environment" and "how they protect themselves from predators". One teacher asks the students to "classify" the animals using their "senses, sight, touch, sound, and taste but from memory only!" and then write a paragraph comparing different animals. Claire's group examines crabs and barnacles and compares them to molluscs such as moon snails, oysters, and a "baby"

octopus. Claire documents her ideas about each animal in her journal and writes that "crabs and barnacles are related", "barnacles are upside down crabs who eat with their feet", "octopus have no bones ... are very soft and squishy", and "moon snails are really cool with their flat fat foot" (conversation/journal, January 14, 2004). When I speak with Claire about her journal entry, she remarks that her invertebrate information sources include her own observations and prior knowledge as well as Diane, her teachers, Pat the wet lab volunteer, and tank labels.

Thursday begins with Animal Observations, followed by an entire afternoon dedicated to sharks. In the morning, Claire appears confident that her animal companion is in good health so her observations focus on Vinegar's daily rituals. She tells me that he begins each day by investigating the nooks and crannies of his coral-clad home. He often pauses to "say hello" to other seahorses but is quick to resume his leisurely rounds. Claire also observes that Vinegar is "a bit of a loner" whose greatest pleasure is to seek sustenance. She notes that he is adept at "ambushing" his Artemia (newly hatched brine shrimp) breakfast. This involves snapping up the tiny crustaceans with his trumpet-like snout. His morning "workout" finished, a satiated Vinegar, confirmed by his "bulging tummy", slowly descends to the depths of his home and secrets himself in a "favourite spot" (conversation, January 15, 2004). Claire visits her seahorse at lunch and at the end of the day notes in her journal that he remains in "his little cave" only to emerge in search of a prospective meal.

Afternoon begins with a scheduled feeding of the sharks for the public and an exclusive visit to the shark penthouse (the enclosure above the shark exhibit) hosted by Dave the head aquarist. During the public event, I overhear Claire explaining the sharks'

behaviour and feeding strategies to her two friends Amanda and Rosie. Afterwards, she mentions to me that "the most impressive" part for her is the aquarist who "gets to swim and feed the sharks." During our tour of the shark penthouse, Claire asks Dave numerous questions including: "How can you tell male from female?", "Who's dominant?", "How long are they pregnant for?", "Would they eat a seahorse?", and "How come these sharks have five gills and some have six?" (conversation, January 15, 2004).

Friday is the final day and the students' activities include morning Animal Observations, an ode writing lesson, and public gallery readings of the completed odes. Prior to her morning observations, Claire confides in me that she is disappointed that the teacher-appointed task for Friday morning is to choose another animal to observe. Though sad to leave Vinegar, she decides to "check out" Wings the dolphin. She tells me she is "dolphin crazy" and has a dolphin-themed "bedroom and sheets" (conversation, January 16, 2004). She thought of choosing Wings as her observation animal but ultimately selected Vinegar as she "already knew everything there is to know about dolphins" (interview, January 16, 2004).

Claire watches Wings and compiles detailed notes describing the mammal's "speed swimming" behaviour and includes drawings of the dolphin's aerodynamic form, grey and white pattern, and "polka dot tongue" (journal, January 16, 2004). She also records "the number of times he breathes in one minute" (an idea she "borrowed" from the Expert Talk with sea lion trainers), and describes the interactions between Wings and his trainer (conversation, January 16, 2004). As the morning activity concludes, I ask Claire to reflect on the experience of watching a new observation animal. She acknowledges that she enjoyed "getting to know Wings better" but misses Vinegar and is

eager to visit him "just to make sure he's ok", which she does just before lunch (interview, January 16, 2004).

After Animal Observations the class congregates in the Centre's boardroom for their ode-writing lesson with the student teacher completing his teaching practicum with the class. The purpose of the lesson is for the children to compose a poem about their observation animal which they will perform in the galleries that afternoon. To begin the activity, all three teachers help the children define the term 'ode' and together the class describes an ode as a poem dedicated to something really special. The teachers then ask the class to write down descriptive words about their observation animal that they can use in their ode. Claire creates an ode vocabulary list from her journal entries and includes Vinegar-inspired terms such as "camouflage", "armour", "hooked-on tail", and descriptive phrases including "vacuum tube snout", "bobbing up, bobbing down", and "ambush moves" (journal, January 16, 2004). After lunch the children perform their completed odes alongside their observation animals. Claire stands before the home of her "pale friend" and recites the following testament to her week with Vinegar:

Alone
Bob up, Bob down
I do it all alone
Pick and chew, Chew and eat
I eat all alone
Maybe someday
Today
The fish will eat and bob with me!

(Claire, Grade 6, Ode, January 16, 2004)

Claire's Environmental Knowing

As Claire participates in the WaterWorlds programme and reflects upon her experiences, she deepens and strengthens her environmental knowing. After an indifferent start, she enthusiastically engages in a week of activities and forges a close relationship with her observation animal. She arrives at WaterWorlds with a solid foundation and significant scientific knowledge about the form, behaviour, and physiology of certain marine animals and thus she begins the week with the belief that there is little more she can learn. As Claire gains new knowledge of the ocean and its inhabitants, she becomes excited, and realizes the WaterWorlds programme provides her with new learning opportunities.

Claire's previous knowledge came from reading books and through internet searches on "sea animals like whales and dolphins, and tropical fish" (Claire, Grade 6, conversation, January 12, 2004). She initially relies heavily on her previous knowledge and information she draws from exhibit labels. However, as she engages in various activities she begins to focus more on knowledge gained through the range of experiences provided in the programme. The focus on "label" facts changes as Claire discovers **new ways of learning** about the environment. Her subsequent journal entries reflect knowledge she constructs from her interview with the seahorse aquarist and her direct observations. Her anecdotal account of Vinegar's daily routine is derived from her personal experiences and interactions with her observation animal. Claire's focus on personally constructing understanding is apparent on the last day of the programme. Her journal entry about her second observation animal Wings details the knowledge she has

acquired through her direct observations, ideas, and personal reflections on the dolphin's form, behaviour, and physiology.

Along with Claire's growth in environmental knowing there is evidence that her **approach to learning** also changes during WaterWorlds. On the first morning she assumes a didactic teaching role with her friends. As the week unfolds, her conversations during the activities become strategy for knowledge construction. For example, she interviews Vinegar's caregiver and asks about the seahorse's health, physiology, and "camouflaging ways". During the Wet Lab and Artefacts, she discusses her observations and ideas with other classmates and draws upon information from other activities such as the sea otter feeding, beluga show, and the BTS tour. Claire's response to the tour provides a further illustration of her recognizing the value of knowledge developed through direct personal experience. She describes the tour experience as "boring" and "especially snoozeable" as she "didn't learn anything great" and "couldn't touch" or "spend time" with the animals (interview, March 5, 2004). It appears that the programme experiences provided Claire with new knowledge about the marine environment as well as an understanding of and a respect for different approaches to learning.

Claire's concern for the natural world and care for the species that inhabit it deepen throughout the week. Initially she describes most marine animals as "dumb" and "boring", but as she experiences the various activities her views change dramatically. A significant event leading to this change appears to be her "adoption" of the small and vulnerable seahorse as her observation animal for the week. Initially she characterizes the seahorse as "cute" and "lonely" and feels "sorry for him with his fragile body and little pouch" (interview, January 12, 2004). By the middle of the week she expresses

concern for Vinegar and her animal's health. By the end of the week, her ethic of care extends beyond Vinegar and she voices concern over seahorse harvesting and habitat loss. She worries about the fate of wild seahorses and decries the fact that "we have laws, but people still harm them" (interview, March 5, 2004).

Claire's relationship with her observation animal shaped an ethic of environmental care and forged personal and emotional connections with the natural world. In her comments, it is clear she regards humans and their endeavours as a part of the ecosystem. On the last day of WaterWorlds, she speaks about the loss of a coral reef and its inhabitants and the effects on local people who rely on this natural resource for economic purposes and "to feed their families" (interview, February 16, 2004). Claire confirms her ethic of environmental care for both seahorses and people during her post WaterWorlds interview as she considers possible consequences of reef conservation:

> If the coral reef is destroyed they (seahorses) won't have anything to hold on to. ... it would put lots of people out of business. They can't eat and have medicine to help their families. (Claire, Grade 6, interview, March 5, 2004)

Claire has not yet fully realized the tension of how drawing upon the reef for food threatens its existence, but her statements reveal a developing understanding of the fragile balance of nature and a growing concern for what might happen when this environmental equilibrium is disrupted.

This connection was forged through what Claire identified as shared life experiences. Claire identifies with her observation animal Vinegar and claims they are "a lot alike", with shared life experiences. She refers to herself and Vinegar as "late crowd joiners" and describes both of their lives as "lonely". On the last day of WaterWorlds,

Claire explains her connection with Vinegar in terms of what she interprets as their shared social status:

> At the beginning of the year I had no friends. I think Vinegar was the same when he first came here. I can tell by the way he is always alone ... with his head down. (Claire, Grade 6, conversation, January 16, 2004)

Claire's ode portrays her ethic of care which embraces her experiences with Vinegar and her **strong emotional connection** to the seahorse. During her ode performance, she begins quietly but concludes with a broad smile and declares, "Thank you Vinegar, I love you!" (conversation, January 16, 2004).

During Claire's post WaterWorlds interview her responses provide evidence of the impact of the experience one month after the programme concludes. She continues to espouse her commitment to and care for her tiny observation animal. She reflects on how Vinegar's circumstances mirror her own and explains that "just like in Vinegar's family" her father is the sole parent and caregiver:

> I wonder who the mom was, but Vinegar will take good care of the babies 'cause I know my dad took good care of me. I don't have a mom either, and my dad did just as good. (Claire, Grade 6, interview, March 5, 2004)

Claire's experiences most notably the relationship with the seahorse inspired a worldview of **advocacy and environmental action** both locally and globally. Thinking about ways to help Vinegar and his relatives survive contributed to her environmental advocacy and commitment to action on behalf of the seahorse species, coral reef ecosystems, and the ocean environment as a whole.

Claire began the programme with limited ideas about environmental advocacy and action and could articulate only simple and local solutions. But as she participates in the programme activities, her response to environmental issues evolves and becomes less

insular and more sophisticated. By midweek she adopts a more global view. She becomes aware of environmental problems concerning seahorses worldwide such as "fishing them too much" and "damaging coral reefs" (conversation, January 14, 2004). By her final day she has augmented her advocacy ideas and can offer an action strategy:

> We need to protect the coral reefs because seahorses need to hold on with their tail. Where would they have their babies? If we tell people which seahorses are the best to take, we can save the rare ones. Maybe they could breed their own seahorses like we do here. (Claire, Grade 6, interview, January 16, 2004)

While her action plan continues to focus on 'collecting', her attention to selective harvesting of seahorses suggests that she has begun to think about protecting biodiversity by limiting the harvest of less common species.

Claire's development as an environmental advocate continues after her participation in the WaterWorlds programme. She refines her ideas for environmental advocacy, and her actions incorporate a personal and creative component for her direct involvement. Her answer to the seahorse's environmental dilemma is to put her Vinegar-inspired poetry to music and sing her seahorse stories to the world:

> I would like to learn to play the guitar and write songs about seahorses. That way I could tell people about how wonderful and precious seahorses are. My songs will make them stop harming seahorses, and it will be their own decision. (Claire, Grade 6, interview, March 5, 2004)

Claire then expands upon her vision for action to encompass the ocean environment as a whole:

> I've written a lot of stories and poems which take place by the ocean. My dream was to live by the ocean, and I got it (to live by the beach). If people heard my songs and poems about the ocean they would feel the same way and care about helping animals too. (Claire, Grade 6, interview, March 5, 2004)

Claire's words and actions illustrate that the WaterWorlds programme has influenced her thinking about and advocacy for the environment. Further testimony to

the significance of this experience is the fact that after the programme, Claire discloses her intention to become a marine biologist. After meeting, speaking with, and observing Centre staff such as "aquarists like Dave", "the sea lion trainers", her "friend" Diane, researchers, and the "shark diver", she is inspired to "to study and work with animals":

> I want to be a marine biologist ... to make sure that people took captive seahorses and other fish for their aquariums at home. (Claire, Grade 6, interview, March 5, 2004)

Oliver's Story

During my experience as WaterWorlds coordinator and while conducting this study, I calculated that more than sixty percent of the boys I observed in the programme chose sharks as their observation animal. These Shark Boys[2] select the shark because they perceive it to be 'active', 'mean', 'dangerous', 'vicious', 'scary', and 'mysterious'. I decided to closely study Oliver because he is one of the boys who chose to study sharks as their observation animal.

Oliver is eleven years old and is in the same Grade 6 class as Claire at Oceanview Elementary. He first enrolled at Oceanview in September when his family moved to Canada from South Africa. I learn from Oliver's father who joins the class for three days as a parent volunteer, that Oliver greatly misses South Africa, is very knowledgeable about sharks, and enjoys learning "anything about animals particularly sharks" through reading books, watching television documentaries, and playing computer games (conversation, Steve, Oliver's parent, January 12, 2004).

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[2] I first became aware of the term 'Shark Boy' from Lisa, the creator and first coordinator of the WaterWorlds programme.

Oliver's Experiences

The **first day** for the students includes attending shows and feedings, selecting an observation animal, and 'free time' in the afternoon for individual exploration. I meet Oliver after lunch as he and five other boys jostle for position in front of the shark exhibit. I listen to the boys' animated conversation about "shark attacks", "killer" species, and "deadly sharp teeth", and conclude that all six are Shark Boys. I learn from Oliver that he decided to observe sharks long before his first day at the marine science Centre and that he has chosen a specific shark he calls "the dominant female" as his observation animal. He tells me he became familiar with sharks through television documentaries and computer games, and it is their "action" life style and "vicious ways" that intrigue him. He tells me some of his "favourite" shark facts include "sharks are different from other fish because they have no bones ... live a long time ... will sink if they stop moving, no air bag ... and have teeth on their skin" (conversation, January 12, 2004).

As he begins his **Tuesday** morning observation, Oliver mentions to me that "some of the reef fish" are "missing" from the day before. I suggest that he speak with the tropical aquarist who "checks on" the sharks every morning to make sure "everyone is healthy and behaving" (conversation, Alan, tropical aquarist, January 13, 2004). After their conversation, Oliver informs me that the school of trevally fish (a member of the jack family which also includes tuna) that reside with the sharks is decreasing. Oliver adds that "the case of the vanishing fish" is a recent occurrence which both he and the aquarist suspect is due to the once nimble fish becoming "old and slow". Oliver concludes that the trevally fishes' poor physical condition is "not a good way to be when

you live with a school of mean black tipped reef sharks" (conversation, January 13, 2004). He writes his morning observations and includes, "my shark is calm … silent" and "always swims". He also notes that "they have two small nostrils", and in preparation for Wednesday morning he writes questions to ask the shark aquarist including, "Why is the top of the tail bigger than the bottom?" (journal, January 13, 2004).

During the Artefacts activities, Oliver makes a rubbing of the sea turtle shell and tells me "they live with the sharks you know". He sketches the piranha and labels his drawing "man eating fish" (conversation, January 13, 2004). Oliver's journal also describes the sea otter's "super soft and warm fur" and details its near extinction due to the fur trade. He writes, "The people kept on killing the sea otters until they were extrapated (sic) (extirpated-extinction from a previously inhabited area) … and the kelp forests disappeared … so they got some more sea otters" (journal, January 13, 2004).

During the sea lion Expert Talk, Oliver stands quietly with two friends as Diane introduces the trainers and their three charges. He follows every move of the sea lions as the large mammals gambol about both in and out of the water catching fish and giving their trainers numerous wet and whiskery kisses. After the talk, Oliver pens his sea lion reflections in his journal "When they eat the whole fish the bones don't get digested. It just goes in and comes out", "I wonder how they make those strange sounds …. and if they make those burping sounds because they eats lots of fish.", and "They have fingernails … lots of blubber and fat" (journal, January 13, 2004).

On **Wednesday** during morning Observations, I notice that Oliver's journal entries concentrate on the shark's behaviour. He describes "the dominant female", as the

"largest, most mean, and tells everyone what to do" (conversation, January 14, 2004). He observes that the sharks "are moving stealthy through the water" and tend to "go in circles, to circle their prey" particularly when "checking out the trevallies" (journal, January 14, 2004). Oliver also writes about the fish's movement which he attributes to the dorsal fin, "great for in line control", the pectoral fins which provide "excellent horizontal ability with low drag", and the caudal fin, "a nice power option" (journal, January 14, 2004). After reading the gallery information on sharks, Oliver excitedly tells me about the fish's "two extra senses" which "detect vibrations and electricity" (conversation, January 14, 2004). He concludes the hour by composing a list of questions about the sharks to ask the aquarist on Thursday morning including "Is my shark pregnant?", "How many babies does she have?, "Are these kind of sharks endangered?, and "Where did my shark come from?" (journal, January 14, 2004). The BTS tour follows observations, and since Oliver is not in my group I ask him about the experience at lunchtime. He describes the experience as "interesting" because he "saw the tanks from the top and behind" but "a little disappointing" because he "didn't see any sharks back there" (conversation, January 14, 2004).

The Wet Lab assignment is to classify marine invertebrates based on the senses and then note similarities between different animals. Oliver focuses on the crustaceans and groups the hermit, Dungeness, kelp, and green shore crabs together as "they all have bones on (the) outside", "breathe through their mouth", and "make bubbles and sounds when outside the water" (journal, January 13, 2004). He tells me that he likes the crab's "toughness" and "big pincers" and "crabby" personality (conversation, January 13, 2004). Oliver then compares the crab to himself and writes that "crabs are like me

because they have all the senses" which include "sight, hearing, touch, taste, smell". He concludes that crabs are also similar to humans as they "have an exoskeleton but that is still a skeleton" (journal, January 13, 2004).

Thursday brings morning observations and an afternoon of viewing sharks. Oliver uses observation time to obtain answers to his questions. He learns from the shark aquarist that "the female is probably pregnant", "she's had four babies already", "lots of sharks are endangered but not mine" and "the rest of the trevallies probably won't make it to the weekend" (conversation/journal, January 15, 2004). He jots down descriptive phrases in his journal on this "nice unique animal" who is "pure snow white" with a "torpedo shape". He expounds upon the shark's "excellent agilitay" (sic), "infinity (sic) teeth supply," and "stunning array of senses" (journal, January 15, 2004). Oliver tells me he is particularly impressed by the stark contrast of the shark's gray and white "counter-shading" (dark dorsal surface and white underside) and "the shifting moves" of the "sturdy yet flexible ... cartilage skeleton" (journal, January 15, 2004).

During Shark Afternoon Oliver raises his hand in response to every question and provides detailed accounts of the species' biological classification, life history, and population distribution. His eyes widen and he quietly utters a "Wow!" upon hearing that "an estimated twenty to two hundred million sharks are killed every year" which is in stark contrast "to the five to ten people who die each year in shark attacks" (Expert Talk, shark naturalist, January 15, 2004). After this activity, Oliver makes a journal entry on "super new shark information" acquired during the public feeding and the penthouse visit. He writes that "Sharks don't want to eat humans they just mistake us for seals", "Some sharks are endangered because of shark fin soup and also for their teeth", and "in

2002 three humans were killed by sharks and 100,000,000 sharks were killed by people" (journal, January 15, 2004).

On **Friday** the students complete their final Animal Observations. They write odes that they present to their class in the afternoon. The teachers ask the students to switch to a new animal for morning observations, and Oliver decides (like Claire) to study Wings, the dolphin. He tells me he plans to compare marine mammal data to his "four days of shark observations". His journal entries describe the dolphin's "nice grey and white" colouration, movement such as "swimming smoothly, individual characteristics including "a squeaky voice", and adaptations for example "the dorsal fin faces the back and helps Wings glide in water" (interview/journal, January 16, 2004). Oliver appears to enjoy his time with Wings and produces detailed observations and drawings of the dolphin. When the hour concludes, I observe Oliver rushing back to the tropical gallery. As he hurries by me, he shouts "I'm going to find out if there are any trevallies left!" (conversation, January 16, 2004).

During the ode writing lesson, Oliver refers to his journal entries for ideas and lists descriptive words including "aggressive" and "aero-dynamicly (sic) shaped", and phrases such as "The body is sleek, streamlined, elegant engineered", "I think sharks are really cool.", and "It's nice how they swim very smoothly with good agilitay (sic)" (worksheet/journal, January 16, 2004). That afternoon, in a strong and confident voice, he recites his ode standing before the shark exhibit with his animal, "the dominant female" gliding by through the sun-lit blue depths.

Oliver's Environmental Knowing

Oliver begins the programme with a 'Shark Boy' passion for fish species that he views as "dangerous" and "vicious". As he progresses through the week he moves beyond his pre-conceptions and his thinking becomes informed by the new experiences. Oliver focuses less on the "tough" and "mean" traits of the animals and broadens his interests to encompass ecology, ocean biodiversity, and conservation. He shows a growing understanding of the physiology, adaptations, locomotion, communication, behaviours, aesthetic qualities, and environmental problems of the organisms he encounters.

Oliver brings considerable environmental knowledge of sharks and other marine species to the WaterWorlds programme. At the beginning of the week, his conversations and work show that his knowledge focuses on his observation animal's predatory temperament as well as on biological facts such as "sharks are cartilage fish", "they are predators", and "have gills" (journal/conversation, January 12, 2004). By Tuesday, his journal entries detail his observations and describe the shark's colours, patterns, and camouflage. He **moves beyond recording shark facts** and notes his shark's "calm" and methodical swimming and "organized" schooling behaviours (journal January 13, 2004). By midweek, Oliver extends his knowledge focus to include his observation animal, the shark as a top predator, and the animal's environmental status worldwide. In his conversation with the aquarist, he asks whether his "dominant female" shark is "pregnant", "how many shark species are endangered", and "Are they eating the trevallies because they are getting old and weak?" (journal, January 15, 2004).

As he engages in the other activities Oliver maintains his curiousity about "tough" and "vicious" marine animals, but also shows a broadening of perspectives in his written work. His work at the three Artefacts stations reflects **an aesthetic view** and an interest in animal behaviour and conservation. He writes that the sea turtles "are tough enough" to reside with the sharks, describes the vibrancy of their "checkered green shells", and notes their "smart" shark-wary moves and "smooth and easy" swimming patterns. He characterizes the piranha as "man eaters" but also appreciates the aesthetics of their "sparkly red" bellies and "calmness" while feeding. He praises the aesthetic qualities of the sea otter's "soft" and "luxurious" fur and describes the animal's near extinction and subsequent recovery (journal, January 14, 2004).

Prior to the Expert Talk on sea lions, Oliver tells me he can "hardly wait" to see the mammals' "sharp teeth in action", but his written reflections focus primarily on information provided by the trainers and his personal reflections on the experience. His questions after the expert talk show movement from 'predator focused' knowledge to thinking about sea lion physiology, communication, and adaptations. For example in his journal entry Oliver wonders how the Stellers digest fish bones, asks "how they make those strange sounds", is curious about "what they are saying" and ponders why they "have fingernails" on their flippers (journal, January 13, 2004).

Oliver's knowledge resulting from the Wet Lab also goes beyond an interest in 'sharp teeth and claws' to include his view of invertebrates derived from direct observations. He initially describes the crabs as "aggressive" and "sturdy" (conversation, January 14, 2004) but then focuses on adaptations, feeding strategies, and survival techniques. He writes about their "sharp claws" and notes that their "flat bodies ... are

perfect for camouflaging", and the "telescope eyes ... help them see from under the sand" (journal/conversation January 14, 2004). His Wet Lab experience also evokes an aesthetic sensibility as he describes the king crab's "beautiful purple orange shell", the hermit crab's "hairy knees", and the sea cucumbers "soft and rubbery ... like a pickle" body (journal, January 14, 2004).

On the final WaterWorlds day, Oliver again reveals his **change in knowledge focus** when he chooses to study the dolphin, an animal with a temperament decidedly more gentle and less aggressive that sharks. His observations focus on the mammal's swimming behaviour and the hydrodynamic shape of the dolphin's "perfect for swimming" form. During ode writing, he again employs knowledge based on his direct experiences. His vocabulary list on his observation animal incorporates his personal reflections on this "elegant engineered" animal. He draws upon the following journal entry to create his ode:

> The body is sleek, streamlined. The pectoral fin is for excellent horizontal stability with low drag. I like their aero dynamic torpedo like body. ... Sharks have an excellent sense of smell that can detect a drop of blood 2 miles away. (Oliver, Grade 6, journal/interview, January 16, 2004)

Although Oliver incorporates his knowledge and personal reflections into his ode, he does not ignore his Shark Boy roots. His completed poem pays homage to the characteristics that first compelled him to choose the shark. His words are a testament to the progression of his environmental knowledge which he melds with his previous understanding of sharks, his attraction to their predatory nature, and his WaterWorlds experiences:

Sharks oh fantastic sharks
You amaze me
I like your torpedo like body
with
Rough sandpaper skin.
Just like my father's rough chin.
You are not so aggressive, but stealthy
When you get aggressive, you are hungry
Jaws snap
None stop
until you get what you want at the top.
A slice of meat will do the job.
Too bad you get killed 100, 000, 000 times a year
But good for you I'll never do that in any year.
Long live my best shark friends.

(Oliver, Grade 6, Ode, January 16, 2004)

Oliver's gains in environmental knowledge are paralleled by **changes in his ethic of care** that reflect an emotional connection which he describes in terms of friendship with his observation animal. His direct experiences with the "dominant female" prompt him to reflect upon this species' place within the ocean ecosystem and consider environmental problems such as destructive fishing practices and rapidly dwindling populations.

Oliver's ethic of care is evident in his deepening relationship with his observation animal during the programme. On the first day, he expresses concern for the shark species. He is aware that sharks are frequently "killed for fun and their fins for soup" which he finds "unfair" as "sharks do lots to help in the ocean like eating dead things" (interview, January 12, 2004). As he spends time with his observation animal, his concern becomes more personal and is evident in his questions for the shark aquarist that ask about the female's pregnancy and the population status of her species. Oliver also

shows caring for his shark in his ode as he laments the species' current environmental problems:

> ... too bad you get killed 100, 000,000 times a year. (Oliver, Grade 6, interview/Ode, January 16, 2004)

Oliver's work during other WaterWorlds activities reveals environmental caring and **concern for animals other than his observation animal**. At the Artefacts writing station he does not describe the skins of 'dangerous' and 'aggressive' animals such as the snake or caiman but instead selects the sea otter pelt. His narrative admonishes the "greedy fur traders ...(who) extrapated (sic) the sea otter right out of British Columbia's coast" (journal, January 13, 2004). During and after the programme experiences, his concern for the survival of marine animals expands to include other shark species "like the great white" and "whale shark" as well as the ocean ecosystem. For example during his post WaterWorlds interview, Oliver tells me that "sharks everywhere need our care and protection" and "the shark is a scavenger and without him there would be lots of waste in the sea" (interview, March 5, 2004). He also begins to recognize that eliminating all shark fishing is not the answer, but some reduction is necessary to allow threatened populations to recover. When I ask Oliver about shark conservation, his responses embody his developing ethic of care:

> Q: What would you say to people who kill sharks?
>
> A: I would tell people about the sharks and how sharks are a good thing in the ocean ... I heard that the great white shark is starting to get extinct so we must stop killing the sharks.
>
> Q: What would you say to people who make their living from killing sharks?
>
> A: I would say find something else so the shark family can reproduce, and once they reproduce, don't kill as much as what you used to (Oliver, Grade 6, interview, March 5, 2004)

Oliver's emotional connection with his shark may in part to be related to his past experiences with the species. While living in South Africa, he spent time at the local aquarium that was home to many of the same marine species he encountered during WaterWorlds. Oliver's father comments that the programme appears to help Oliver cope with the displacement and strangeness of their family's recent move (conversation, Oliver's father Steve, January 15, 2004).

While Oliver's comments are not overtly emotive, his feelings emerge in his ode when he writes "long live my best shark friend" (Ode, January 16, 2004). Oliver does reveal his emotional connection post WaterWorlds when he looks back upon the week and remarks that his best memory was "when my shark stopped to say hi each morning, even when I wore a different jacket!" (interview, March 5, 2004).

Oliver's deepening relationship with his observation animal also inspires **environmental advocacy and a plan for action** that encompasses not only a global perspective regarding shark-human interactions but also consideration of the significance of preserving sharks as part of the earth's biodiversity. Oliver begins the programme with some general ideas for environmental advocacy because he is aware of problems affecting sharks such as over-fishing. He is also cognizant of the disconnect between humans and sharks and states that "many people don't understand sharks" (conversation, January 12, 2004). Through his experiences in the programme, he develops an environmental awareness that relates to his observation animal and later includes shark species worldwide. Post programme, he speaks about stopping "huge shark kills" caused by pollution, over-harvesting, and drift nets (free floating nets).

After WaterWorlds concludes, he continues to refine his notions of advocacy and environmental action on behalf of sharks and related species forming ideas for environmental action such as creating a website dedicated to sharks. He describes his plan during our post WaterWorlds interview:

> Q: How would you get that information out about sharks?
>
> A: I think I would write a story and draw pictures and put in on my shark website.
>
> Q: What would your story be about?
>
> A: It would be about like maybe a guy has taken a pregnant shark and put it in an aquarium and like there are very little of that type and then they keep that shark there for some time and then in the real sea all the shark of that type are extinct. And then without that shark because the shark is like a scavenger there is lots of waste in the sea (Oliver, Grade 6, interview, March 5, 2004).

I include Oliver in this chapter for his Shark Boy attributes. His story is also representative of boys who participate in WaterWorlds. Although Oliver does not overtly show his feelings, he establishes a strong emotional connection with his observation animal the shark. As he engages in the week's activities he maintains his curiousity about the predatory nature of marine species and develops a broader perspective derived from his direct encounters with the other animals. From his experiences in the programme and particularly from his relationship with the observation animal, Oliver builds upon his environmental knowledge, ethic of care, advocacy, and commitment to action and gains a greater understanding of the ocean realm.

Faith's Story

Faith is ten years old and in Grade 4 at Mariner Elementary. She has attended Mariner since kindergarten and lives with her extended family on the First Nations

reserve which borders the school grounds. On our first meeting I find Faith to be shy, but when I speak with her about WaterWorlds her quiet but enthusiastic responses indicate her interest in, and excitement about, the programme.

I include Faith's story because as one of the 'Dolphin Girls'[3] she provides a counterpoint to Oliver. Faith was excited by the dolphin, Wings, "because he is cute", "jumps really high", and "is so beautiful!" (conversation, November 24, 2003). Although Faith does not observe the dolphin until her final day in the programme, she ultimately expresses a 'Dolphin Girl' enthusiasm for her primary observation animal the white sturgeon. Faith begins WaterWorlds with a love of dolphins, and through her experiences in the programme develops deep feelings for a less popular observation animal, the sturgeon.

In addition to her preference for a beautiful and graceful observation animal, I find that Faith's inclination to participate in activities alongside her three "best friends" to be characteristic of the social behaviour exhibited by the majority of the girls in the programme. Also, Faith's story holds another significant place in this case study because her engagement in and response to the programme reflect her First Nations background and reveal influences of her culture, community, and family.

Faith's Experiences

On their **first day,** the Grade 4 students engage in gallery explorations, attend all shows and feedings, and choose their observation animal. When I first encounter Faith,

[3] As with the term Shark Boy, the phrase Dolphin Girl also originated with the WaterWorlds programme creator.

she is with a vocal group of girls. I judge from their animated conversations that the four girls are friends. I question them about their observation animal prospects, and they gleefully reply in one voice, "Wings the dolphin!" I ask "Why?" and they again respond in unison, "He is so cute and jumps so high!" I notice that Faith shyly echoes her friends' sentiments but her responses are less emphatic. I am interested in the girls' individual reasons for selecting Wings, and I engage each in conversation. When I ask Faith, her more assertive peers answer for her so I decide to talk with her alone that afternoon.

During lunch break, the teachers propose that some students reconsider their observation animal choices due to a preponderance of girls wishing to observe the dolphin and too many boys selecting sharks. They suggest that those contemplating a switch should think about choosing an "inside" animal that is resident in local waters. Together with programme coordinator Diane, the teachers discuss various candidates with the class. After lunch the students return to the Centre and begin the afternoon with a thirty minute "get to know your observation animal" session.

While the students study their observation animals, I cruise the galleries taking notes on their choices. I am surprised to discover Faith scrutinizing the dark green depths of the Pacific Coast exhibit which is home to a multitude of indigenous marine life. She is with one of her Dolphin Girl friends and both are following the travels of a two-metre long sombre-grey fish slowly circling the tank. I ask about their observation animal, and the girls introduce me to their final choice, the white sturgeon. During "free time" both girls make a quick visit to the dolphin exhibit to "say hi" to Wings and then return to spend the rest of the afternoon with their sturgeon.

Tuesday begins with Animal Observations in the morning, an Expert Talk on scientific illustration before lunch, and an afternoon Wet Lab. Faith begins her observations recording label information and drawing the sturgeon in her journal. During our conversation she declares that she "likes his bumpy body" and the "way you can see his white mouth beside his grey skin" (conversation, November 25, 2003). As we chat Faith reads a list of sturgeon facts she has transcribed from the tank label information. "He is not a shark even though he looks like one" and his mouth is located "underneath him so his prey won't see it, and because it is very sensitive." Faith then confides that the sturgeon's barbels also "make him look a bit scary" (conversation, November 25, 2003).

During the Expert Talk, the students participate in a drawing lesson of a Pacific pomfret fish led by the Centre aquarist Dave. Faith sits with her three friends, but rather than joining their non-WaterWorlds related conversation, she focuses on Dave following his instructions and completing her fish drawing. When I mention her expertise and obvious enjoyment during the lesson, Faith comments, "I draw with my mom a lot. She's good at drawing animals." When I inquire about the subject of their artwork she replies "animals that we see, you know, racoons, birds, ... and sea animals from our boat in the summer like seals and otters" (conversation, November 25, 2003).

In the afternoon Wet Lab, the teachers ask the students to study different groups of invertebrate intertidal animals displayed on four separate tables. The task is to explain why the animals are placed together by looking at each organism's external characteristics, movement, and adaptations. Faith is an active participant as she strokes the "sticky tentacles" of the anemones, observes the hermit crab's "hairy legs" emerge from his shell, and gingerly handles the "prickly ball" of a sea urchin (conversation,

November 25, 2003). In her journal, she describes the crabs and barnacles as "sharp", "crawlers", "hard and bumpy", and "can be tasty"; the clams and oysters as "soft with hard shells", "good to eat", "hide in sand"; seastars, sea urchins, and sea cucumbers as "prickly", "slow", and "spiny"; and the anemones and sea pens as "soft", "like plants", and "jiggly" (journal, November, 25, 2003). Faith tells me that she is familiar with many of the wet lab animals because she and her "mom and aunties" collect oysters, clams, and "crabs sometimes if it's low tide" from beaches in the summer. As we leave the wet lab, she adds that her favourite moments include "watching the scallops fly" and "learning that barnacles eat with their feet!" (conversation, November 25, 2003).

Wednesday begins with observations and a BTS tour. During observations Faith has many questions about her sturgeon so I suggest she interview the aquarist in charge of the fish's care. I listen to the interview and note that Faith's questions pertain to the animal's health, food preferences, personality, and the environmental status of local populations. Faith writes in her journal that, "My sturgeon is from the Fraser River and likes to eat herring", "He is quiet", "Sturgeons are a bit of a mystery", "They live approximately 50 to 100 years", "The females lay up to a million eggs", "They lay eggs every four to eleven years", and "They must be at least eleven years old to breed" (journal, November 26, 2003).

After the interview Faith discusses her morning observations with me. She notes that her sturgeon enjoys "snacking" on the herring that inhabit the exhibit's upper layer. She tells me about her animal's "hunting moves" and demonstrates the sturgeon's feeding behaviour by "pretend swimming" about the gallery, opening and closing her mouth to simulate the fish's gasping mouth as it vacuums in skeins of herring. During her

performance, she describes the process as a "sneaky attack" and explains that the sturgeon "finishes the job" by slowly floating belly-up to the surface and "sucking in" its unsuspecting prey with lightning speed (conversation, November 26, 2003).

Faith is not with her usual three companions during the BTS tour because the teachers divide the class into five separate groups. Although a quiet participant, Faith appears to enjoy the experience as she lingers over the tanks of breeding lumpsuckers and pipefish, quickly locates the baby octopus hiding in a flower pot, and watches intently as the dolphin trainer demonstrates how to hide vitamins in herring gills. At the end of the tour, Faith is the first of our group to locate the 'favourite' animal she chooses during the tour, a China rockfish, from the gallery side of the glass. When I ask for her thoughts on the BTS experience, she responds that she would like "to work as a trainer" and "take care of the whales and dolphin" (conversation, November 26, 2003).

After lunch, the teachers assemble the students for a squid dissection led by coordinator Diane. The students begin with careful observations of external characteristics and talk about the squid's biological classification as a mollusc and cephalopod, adaptations such as body shape and colour, and similarities between people and squid. Working in pairs the students cut open their squid, identify internal organs such as gills, stomach, and the three hearts, and locate the ink sac. They pull out the squid's quill-like pen (remnant of the molluscan shell made of chitin), dip the pen into the ink sac, and write their names in their journals using the squid ink. Diane then shows the students how to remove the lenses from the squid's two eyes and open up the "head" to expose the brain.

Faith appears comfortable carrying out the dissection, to the obvious relief of her more hesitant partner. When I ask her about the dissection later, she explains that she "liked looking inside the squid" and is "used to it" because her uncle showed her how to cut open and clean salmon during family fishing trips (conversation, November 26, 2003).

Thursday includes Observations, Artefacts, and Shark Afternoon. For morning observations, the teachers instruct the class to include a story, poem, or comic strip featuring their animal in their journals. Faith incorporates her daily observations as well as the interview and research data into a short narrative. She sets the story at a science centre where a man "who looks for big and strange fish for a living" brings in a sturgeon (journal story, November 27, 2003). Originally he plans to make "lots of money" from the sale of his fish, but when he learns that he has a "rare sturgeon", he "wants to help it survive." He leaves it with the scientists where "it can be studied and have babies" to help augment wild populations (journal story, November 27, 2003).

For the Artefacts activity the teachers lead a "Discovery and Exploration" focusing on teeth, skulls, furs, shells, and skins from a variety of animals including a killer whale, shark, sea otter, caiman, and sea turtle. The students draw and classify the artefacts, write an explanation for their classification, and then identify their "favourite". The teachers provide guiding questions such as "How can we tell an animal from its teeth?" and "Why do animals have fur?" (journal, November 27, 2003). Faith moves through the artefact stations with her three girlfriends recording each object's distinguishing characteristics. She writes that "flat teeth are for grass eaters and sharp teeth for meat", "seals have flat and thin skin 'cause they have blubber", and "sea otter

fur is thick to keep them warm and dry" (journal, November 27, 2003). I ask her about the source of her artefact classification knowledge, and she responds that she "learned about seals and sea otters from the people at the shows" and during fishing trips with her family. Faith chooses the abalone shell as her favourite artefact while her companions select the sea otter pelt. At the end of the activity when Faith describes her choice to the class, she explains that the abalone is "good to eat", and the shell is used "for jewellery" and "special ceremonies" (conversation, November 27, 2003).

During Shark Afternoon, Faith is again a quiet participant, but her wide eyes and big smile indicate that she is enjoying the activity. As she watches the feeding with her three girlfriends, Faith joins the chorus of "oohs" as the sharks expertly take fish from the diver's hand. She laughs along with her classmates as the "sneaky" ray pokes its snout into the bucket searching for leftovers. In the shark penthouse with the aquarist, Faith and her three friends hold one another's hands as they cross the bridge and assemble along the pool's edge keeping a careful distance between themselves and the schooling sharks below. She enthusiastically tries on the shark diver's mesh gloves and afterwards tells me "I would like to do that job too!" (conversation, November 27, 2003).

Friday includes morning Observations, an Expert Talk with a dolphin trainer, and "good bye time" in the afternoon. For her final observation, Faith selects a new animal as the teachers ask the students to compare two different animals. Faith passes the hour with her original choice, Wings the dolphin. In her journal she notes the similarities between sturgeons and dolphins such as colour, habitat, and prey. She also includes the differences between fish and mammals such as "having warm or cold blood", "breathing through gills or lungs", and giving birth to "alive young or laying eggs"

(journal/interview, November 28, 2003). Faith writes that sturgeon live in both salt and fresh water, and are "anadramous" fish" (a term she learned from the aquarist), whereas Pacific Whitesided dolphins "live in salt water only". When Wings's trainer asks Faith about her journal entry, she shyly shares her work. He tells Faith about species of river dolphins living in China, South America, and India, and she quickly adds this information to her notes. As her final Animal Observation concludes, she confides that she misses her sturgeon but is happy to spend time with Wings because she "loves him too" (interview, November 28, 2003).

The Expert Talk with a marine mammal trainer involves one of the students wearing a dolphin costume and 'being trained' to touch a pole and then receiving food, in this case candy, as a reward. When the trainer asks for a "volunteer dolphin", Faith slides down into her chair while one of her friends raises her hand in excitement. Faith tells me after that she "didn't want to play the dolphin" but "loved learning how to be a trainer" as she "would like to do that job too!" (interview, November 28, 2003).

The students spend the afternoon saying goodbye to their observation animals. Faith and her friend Sharon observe their sturgeon and take photographs of their "shared observation animal". They conclude their final day in the programme by writing "good-bye letters" to the sturgeon in their journals. Although the sturgeon was not her first choice, Faith developed feelings for and a deep connection with the white sturgeon.

Faith's Environmental Knowing

Faith brings to the WaterWorlds experience her knowledge and values about the ocean environment drawn from her experiences with her family and the First Nations

culture. At the start of the programme she is a professed 'Dolphin Girl', but as she engages in the observation activities she extends her passion and excitement to embrace a much less "charismatic megafauna" (Barney, Mintzes, & Yen, 2005), the white sturgeon.

During Observations Faith moves from recording label facts to gaining knowledge derived from daily interactions with her sturgeon and Centre staff. As the week unfolds, she focuses more on her sturgeon's behaviour, feeding strategies, life history, and special characteristics such as the fish's designation as an "anadramous fish". Faith's growing knowledge and shift in focus are evident as she describes her sturgeon during a conversation with me mid week:

> The barbels are like whiskers but they aren't really. They help him find food and touch the water ... he's a fish because of the gills there. He has a bumpy body not scales like other fish ... See his mouth. It's underneath ... and ... sensitive. (Faith, Grade 4, conversation, November 26, 2003)

Faith's **changing approach to knowledge and learning** during the programme is evident in her quest for information that cannot be answered through tank labels. For example during her consultation with the sturgeon aquarist she asks: "How old is my sturgeon?", "Where did you get him from?", and "What's his favourite food?" (conversation, November 26, 2003). After her WaterWorlds experience she continues to broaden her knowledge. In our post WaterWorlds interview I ask her about her animal observations and she replies:

> I liked writing about how my sturgeon looked and what it did. I did a research project on him with a poster after we came back to school (Faith, Grade 4, interview, February 12, 2004)

A range of experiences appears to contribute to Faith's environmental knowing. Her work during the Expert Talk **builds upon her existing creative abilities**, and by week's end she produces accurate and detailed illustrations of animals that **combine both her**

scientific and aesthetic knowledge. For example her first journal drawings are quick sketches of animals and by week's end her compositions portray specific characteristics such as the sturgeon's "barbels" and "bumpy body" and the dolphin's "counter shading" and "hooked for streamlining" dorsal fin (journal, November 27-28, 2003). During the Wet Lab and Artefacts activities, Faith builds her knowledge through direct experience as she classifies animals based on what she sees and feels. She **employs her senses** in her descriptions of the crabs' "hard bodies", the echinoderms "sharp spiny" skin, and the "grass eaters … flat smooth teeth" (journal/interview, February 12, 2004).

Faith's ability to lead her partner through the squid dissection illustrates her **use of prior knowledge**. She is familiar with "opening up" salmon and is able to integrate the process knowledge of 'how to do a dissection' with the product knowledge of 'what to look for' during the squid dissection.

She **builds upon previous cultural experiences** fishing with her family and harvesting shellfish to aid her classification of invertebrates and understanding of marine mammals. She also draws upon her cultural background when she describes the abalone and explains the animal's significance to First Nations' people.

Faith's cultural and family background inform her developing **ethic of care** for the natural world. She initially demonstrates care for Wings the dolphin but this expands to include other species during the programme. She first communicates her ethic of care when she "looks for a different kind of observation animal … and then I see the sturgeon … it's cool … a bit of a mystery … endangered and rare" (interview, November 24, 2003). After the programme concludes, Faith voices her emotional connection for her animal:

> I thought the sturgeon would be boring but when I found out stuff about them, they were so cool. I love them. (Faith, Grade 4, interview, February 12, 2004)

Faith's growing ethic of care is portrayed in her story about the sturgeon that is first captured for monetary gain and ultimately becomes instrumental in repopulating the species. In her narrative, Faith shows her concern for the sturgeon's precarious environmental status as she writes about the effects of over-fishing and habitat loss on the species. She echoes her story's sturgeon-centred ethic of environmental consciousness and concern during our post WaterWorlds interview:

> ... it takes sturgeon a long time to get big and have babies so they are taking sturgeon before they have a chance to lay their eggs. So there is not enough sturgeon to have the babies. (Faith, Grade 4, interview, February 12, 2004)

Faith's ethic of care is also seen through her growing emotional connection with the sturgeon. Initially she describes her sturgeon as "a bit scary" but as the week unfolds she begins to see her grandfather in her animal's appearance and behaviour:

> He reminds me of my grandpa because when he is drawing he is mysterious and doesn't like anyone talking to him. He even kind of looks like a sturgeon 'cause his hair is grey and his face is grumpy sometimes. (Faith, Grade 4, interview, November 28, 2003)

She also finds her sturgeon to be reminiscent of other family members as she observes that "He likes to swim around like my little brother. They both love the water ... water babies you know" (interview, November 28, 2003). Faith's feelings of care continue on after the programme when she speaks of connecting with her sturgeon through her family and her First Nations culture:

> My grandpa's an artist ... he carves. He did a totem pole at my Auntie and Uncle's (house) and at my cousins' school. He could teach me to carve a sturgeon ... a wooden sturgeon ... with barbells and a bumpy body. (Faith, Grade 4, interview, February 12, 2004)

Faith demonstrates her developing ethic during her interactions with other animals at the marine science centre. During the Wet Lab she models how to hold crabs "so their legs don't fall off" and reminds her group about the "pinkie rule" (using the smallest finger to touch) when interacting with the intertidal animals (conversation, November 25, 2003). Her choice of prospective jobs which she learns about during the BTS tour, the two Expert Talks, and Shark Afternoon reveal her growing ethic of care as she speaks about wanting "to help" and "teach people about animals" through working as an aquarist, educator, and member of the Centre's marine mammal care staff (conversation, February 12, 2004).

Although Faith begins the WaterWorlds programme with an interest in and concern for the dolphin, the programme activities enable her to develop deep feelings and an emotional connection for the less popular sturgeon and other animals she encounters during the week. As her experiences conclude, she expresses her "love" for both her sturgeon and Wings the dolphin. Perhaps Faith's ethic of environmental care is best expressed in an exchange that took place post WaterWorlds when she emphatically declares: "I would never eat my sturgeon, even if I were starving. Definitely not ever!", and as she reflects upon the week's experiences:

> Q: What was your favourite thing to do during WaterWorlds?
>
> A: Observation time ... being with my sturgeon. I loved that so much.
>
> Q: Your least favourite time?
>
> A: I liked everything ... except on Friday I was sad because I didn't get to take a picture, because I didn't put the film in my camera properly. My batteries died just before I was going to take a picture of my sturgeon. I was sad about it." (Faith, Grade 4, interview, February 12, 2004)

Faith's growing ethic of care influences her **environmental advocacy,** and her ideas for **environmental action** focus on ways to help marine animals. Faith's advocacy tendencies are evident from the start of the programme when she states that Wings the dolphin would benefit by having a larger pool and a "mate". During her interview with the aquarist she gains a deeper understanding of problems affecting sturgeons and incorporates these issues into her story about a sturgeon captured for sale. Her advocacy message is evident in the story's conclusion when rather than selling the sturgeon "for money" the fisherman acts to save the sturgeon by allowing it to live and "have babies" (journal story, November 27, 2003).

Faith's advocacy evolves to include other marine species when she expresses concern for decreasing populations and suggests ways to conserve commercial species. During the Artefacts activity, she explains how abalone shells are "really hard to find, especially the big ones" and then states, "We need to let the big ones live and have babies" (conversation, November 26, 2003). While participating in the Wet Lab, Faith advocates for sustainable fishing practices when she mentions that taking undersize crabs and clams is not an acceptable practice. She highlights the need for balance between harvesting and conservation when she describes how she collects crabs and clams to eat "but only if they are big enough. You don't take baby ones" (conversation, November 25, 2003). When I ask Faith about how public facilities should obtain dolphins, her response illustrates a conservation perspective on collecting animals for captivity as she suggests that any new dolphin "should come from another aquarium" or "be an injured one" from the wild. She does not "want a dolphin being taken away from its family" (interview, February 12, 2004).

Faith expresses a desire to help animals as well as the aquatic environment and her ideas about taking environmental action are shaped by the programme activities, her family, and First Nations culture. The people she meets during the programme become role models and she speaks about "teaching about animals like Diane", "becoming a fish artist like Dave", "maybe a shark diver", and "a dolphin trainer like Kim" (interview, February 12, 2004). Speaking about what she would do in these different roles, Faith indicates she will "tell people about animals they may not like too much or know about" and "show people how to help animals" (interview, February 12, 2004).

Family and culture play key roles in Faith's environmental action plan. I learn during our conversations that many of Faith's family are commercial fisherman, and her grandfather is a well-known carver. Faith tells me she could help her sturgeon by creating a video featuring her grandfather teaching her how to carve the "old" and "mysterious" fish. The video would also feature Faith "showing people her sturgeon and telling them "not to take the sturgeon so much. I would say, couldn't you eat a different kind of fish?" (interview, February 12, 2004).

Through her participation in the WaterWorlds programme, Faith discovers she can call upon her past experiences with the natural world, culture and family to inform her engagement in and response to programme activities. She draws upon her environmental knowledge and assumes a leadership and teaching role with her friends. She extends her initial environmental ethic of care (for dolphins) as she learns of the sturgeon's precarious environmental status and writes a story that encourages saving the sturgeon species. As she learns of environmental problems such as those affecting the

sturgeon, her ethic of care and advocacy culminates in a plan for environmental action that encompasses herself, her family, and the First Nations culture.

Gary's Story

Gary is ten years old and a Grade 5 student enrolled in the Language Needs (LN) class at Evergreen Elementary school. He was admitted to the LN class in Grade 4 when he was assessed as having a two year delay in English comprehension, writing, and speaking skills. When I speak with Gary on his first day in the WaterWorlds programme, I learn that he enjoys outdoor activities with his family such as hiking, camping, and fishing, and each year he visits his cousins in the Philippines "to go snorkelling with the beautiful fish" (interview, February 16, 2004).

Before the class began their WaterWorlds programme, the teacher tells me, "My kids love to talk. You won't be able to stop them once they start!" (Ken, Evergreen Grade 5 LN teacher, conversation, January 17, 2004). I soon discover the teacher's assessment to be true, and Gary appears to take great delight in conversing with me about his experiences. Thus I choose to focus on Gary in order to understand the ways LN students engage in and respond to the WaterWorlds programme.

Gary's Experiences

I accompany the fifteen LN students from Evergreen Elementary on their **first day** at the marine science centre as they tour the various exhibits in search of observation animals. During lunch, their teacher reviews the observation animal selections with the following results: sharks, 4 students; harbour seals, 3 students; dolphins, 2 students;

belugas, 2 students; Amazon fishes, 2 students; sea lions, 2 students; caiman, 1 student; sea horse, 1 student; piranha, 1 student; and Gary who chooses the damselfish. Later that afternoon I ask Gary about his observation animal, and he responds that he "loves the damsel colours" and "peacefulness" (interview, February 16, 2004). Intrigued by Gary's thoughtful response, I decide to spend time with him as he experiences five days of the WaterWorlds programme.

On **Tuesday** the students begin with Animal Observations and end with a sea lion trainer tour. I meet Gary as he settles beside the brilliantly hued coral reef exhibit and prepares for his first animal observation. Peering intently at the swirling mass of resplendent damsels, he seems oblivious to the noise generated by two boisterous classmates, Jon and Bill, at the adjacent shark exhibit. I ask Gary why he chose the damsel, and he replies that he became acquainted with damselfish while snorkelling on a family vacation and was "won over" by the fish's brilliantly coloured scales and sleek "perfect-for-swimming" form (conversation, February 17, 2004). For his observations, he records data from the tank label on damselfish classification and population distribution in his journal. He chooses a specific fish for his "special" animal, and when I enquire about how he distinguishes "his" damsel from the others, with a keen eye he replies that, "It's all in their movement!" (conversation, February 17, 2004).

In the afternoon the students go outside to the marine mammal deck for the sea lion trainer tour. The trainer tour differs from the usual sea lion Expert Talk as the children have the opportunity to meet, feed, and "train" Tanu, the Centre's adult male Steller sea lion. The trainer tour is one of the Centre's public programmes, and participants are charged a special fee. Gary's teacher tells me that he participated in the

tour during the summer and was so impressed by the experience that he asked to have it included in the students' programme. To pay for their tour, the students held bake sales at school throughout the year (Ken, Evergreen Grade 5 LN teacher, conversation, January 17, 2004).

We approach Tanu's "bachelor pool" and are greeted by Ted, the trainer who works exclusively with the sea lion. Ted introduces us to his charge and tells us that Tanu came to the Centre as an abandoned pup and is now ten years old, weighs six hundred kilograms, and eats twelve to twenty kilograms of squid and herring every day. Ted demonstrates the various hand signals used in Tanu's training, and after answering a few questions, he informs the students that it is now their "turn to 'train' Tanu to speed swim." Gary is the first to volunteer, and following Ted's directions, he signals a series of "speed swim waves" with his right hand. Tanu immediately bounds into his pool, flashes across the water, springboards off the far wall, and returns for his 'fishy' reward. Ted provides the herring which Gary neatly tosses directly into the Steller's whiskered maw. Everyone has the opportunity to "train" Tanu, but, as Gary remarks to me, by the third training session the sea lion "is getting full of herring" which gradually lessens the his enthusiasm as well as his appetite. The children thank both Ted and Tanu as the tour concludes, and we head back inside the Centre. Gary tells me that he enjoyed "just watching Tanu swimming ... more than the training part" because he "really liked the way he moved through the water" and "not just telling him what to do" (conversation, February 17, 2004).

On **Wednesday** the students continue with their Animal Observations, and also participate in the BTS tour and an afternoon Wet Lab. Rather than writing about his

observations, Gary leaves his journal in his backpack and assumes a spectator role. I notice that his shark-keen friends, Jon and Bill, also appear to be in a meditative mood, and the three companions tell me they are "just relaxing" and "liking the heat" of the tropical gallery. The boys compare observation animals with Gary expounding upon his damsel's "beautiful colours" (conversation, February 18, 2004). When their teacher arrives he tells me that he wants the students to work on their written observations because they are already "quite proficient at talking about them!" To provide focus for the three boys the teacher asks them to answer "What makes my animal really interesting?" in their journal. Gary settles down to the task of recording his observations and drawing a school of damsels. He tells me that his "interesting things" are "women and men are different colours" and that "they (male and female fish) like to swim together" in pairs (conversation/journal, February 18, 2004).

At lunch time Gary and I discuss the BTS tour, and he tells me that he "really enjoyed seeing the basement" and "looking at all the fish from behind and on top" (conversation, February, 18, 2004). His favourite part was "feeling the walls" and predicting whether the tank "had warm or cold water things in it". Gary also mentions he "liked talking to the high school students" who accompanied his group on the tour (conversation, February, 18, 2004).

After lunch, we proceed to the wet lab where Diane has set up tables featuring: crabs, prawns, and barnacles; seastars, urchins, and cucumbers; clams and snails; and sea anemones and sea pens. After Diane's introduction, the students spend ten minutes at each table observing, touching, drawing, and labelling the different animals. Gary's illustrations include a "barnacle eating", "a sharp spiny" sea urchin, and a "sticky"

anemone (conversation, February 18, 2004). His favourite Wet Lab experiences are "touching the animals", "seeing the scallops escape from the starfish", and "all the colours" (conversation, February 18, 2004).

Thursday begins with morning Animal Observations and concludes with a Shark Afternoon. Before they begin their day, the teacher again provides the students with "guiding questions" to focus their observations including "What does my observation animal do?" and "How can my animal defend itself from attackers?" As he watches his damsel, Gary tells me that his fish prefers to "bunch up" with "friends" while swimming and then "hide under rocks" during "his alone time". He adds that "the damsel never fights and if it does, only accidentally" (conversation, February 19, 2004). Gary's journal entry includes pictures of "before and after" drawings of the neon-bright damsels. His "before picture" shows the damsels schooling through their coral home, and the "after picture" depicts his observation animal "resting" with his head on a "pillow" of sparkling sand (conversation, February 19, 2004).

To begin Shark Afternoon Diane meets the class at the shark exhibit with a cart piled high with shark jaws, skins, and teeth. As the artefacts are passed around she explains how shark experts can distinguish one species from another by looking at the teeth. Gary carefully strokes a lemon shark hide and describes the skin as "better than the teeth" as "it's prickly ... tough ... and smooth all at the same time". Once the naturalist begins his talk the students fall silent, but I hear Gary whisper to his friend Jon that "Sharks can't catch damsels you know. They're too fast and sneaky for them!" (conversation/observation, February 19, 2004). After the feeding, we proceed to the shark penthouse, and on the way Gary tells me that "sharks are okay, but damsels are the

best". When I ask for clarification, he enthuses over the damsel's tranquility, serenity, and aesthetics and responds that damsels are "peaceful and don't fight and are beautiful too" (conversation February19, 2004). In his journal entry on Shark Afternoon, Gary writes that "one shark is ganging up on other fish", and he "noticed the boss of the sharks, and she is the mother" (journal, February 19, 2004).

On **Friday** the class engages in their final Animal Observations, participates in an Expert Talk about frogs, and has a "free afternoon" for "explorations and goodbye". Prior to Observations, the teacher asks the students to answer "guiding questions" in their journals including "How does my animal move?" and "How does my animal act with other animals?" Gary writes that his damsel "is good at swimming", "is careful about not hitting the coral", and "changes colours when he sees other fish sometimes" (conversation/journal, February 20, 2004). He then adds the words, "Peace and no fighting!" beneath his previous days' journal drawings (journal, February 20, 2004).

The Expert Talk about frogs is led by the Centre's head herpetologist, Alan who arrives with a stack of plastic "frog condos" housing a host of amphibians. He begins by showing the students examples of brilliantly coloured frogs as well as specimens who are "masters of camouflage" and "almost impossible to find" in their leafy abodes. Gary spends the hour trying to locate the frog in each container and asking Alan questions such as "What is your favourite frog?, "Do they fight if you put two in there?, and "What do the colours mean?" After the students locate all the frogs, Alan regales them with stories about catching "deadly" poison dart frogs and also discusses his work with the endangered Oregon spotted frog which is bred at the Centre. He ends on a conservation note as he shows the students "mug shots" of the "destructive bull frog" who "eats all the

other frogs". Alan adds that bull frogs should be eliminated from local streams and ponds to allow indigenous amphibian species to recover from this voracious "alien". As the class thanks Alan, Gary confides in me that even though the bull frog is "bad" he feels that "they should live too", and he "would never kill one" (conversation, February 20, 2004).

After lunch, Gary cruises the galleries and outdoor exhibits with his friends Jon and Bill. The boys rush about the Centre taking pictures, watching shows and feedings, and purchasing mementos at the gift shop. Gary shows me his acquisition, a tee shirt featuring a school of brilliant damsels. Just before the class departs the Centre for the last time, Gary sprints into the tropical gallery "to say goodbye" to his damsel and "hug the tank" (conversation, February 20, 2004).

Gary's Environmental Knowing

Gary's **prior knowledge** about the environment was gained during family camping, hiking, and snorkelling excursions. During the week, he furthers this knowledge through his participation in activities such as Animal observations, the Wet Lab, and Expert Talks. During his first morning of Observations, Gary transcribes facts from the tank label on his fish's size, lifespan, and population distribution. By mid-week his information comes from his observations that show a keen eye and attention to detail as he explores differences between males and females based on colour. His conversations and written work detail the fish's "colours", beautiful moves", and "peaceful ways" (conversation/journal, February 18, 2004). That Gary retains his

knowledge gained is evident during our post visit interview, as he discusses damselfish behaviour:

> They don't bite. They want to stay in groups ... for protection. They can do a lot of things. They can hide in small rocks. (Gary, Grade 5 LN, interview, May 25, 2004)

Gary's Wet Lab conversations reveal his valuing of **information acquired through the senses** when he speaks about feeling the "sticky" sea anemone and the "spiny sharp" sea urchin. As he studies the shark artefacts, he is fascinated by the tactile sensation of the lemon shark skin, and during the Expert Talk on frogs, he is drawn to the amphibians' "amazing colours", "huge speckly eyes", and "smooth shiny skin". Gary again exhibits attention to detail when he mentions feeling the 'hot' and 'cold' tank walls and his conversations with the high school work experience students as highlights of the BTS tour.

Gary comes to the programme with an **ethic of care** that is strengthened and extended throughout the week. At the beginning of the programme Gary reveals his caring when he chooses the damselfish for "its kindness and quietness" (conversation, February, 16, 2004). During Animal Observations, he becomes aware of the fish's sensitivity to "loud sounds" and sudden movements "outside the tank". He expresses his caring in the following words of advice for Centre visitors:

> I will tell them, "Don't hit the glass. Keep your hands to yourself. Respect all the animals and people around you." (Gary, Grade 5 LN, conversation, February 18, 2004)

By the end of the week Gary embraces environmental caring as he extends his concern to damselfish and other marine species world wide when he talks about problems such as "garbage in the water ... shopping carts ... and animals people put in the ocean"

(interview, February 20, 2004). He shows an awareness of the issues around the commercial harvesting of reef fish for food and export, and mentions that "some people catch fish like damsels" for a living. Yet, Gary remains steadfast in his damselfish-centred ethic of care. When I ask him what he would say to those who feed their families by selling reef fish, he responds:

> How would you feel if you were away from your family and someone killed you? (Gary, Grade 5 LN, interview, May 25, 2004)

Gary's developing ethic of environmental care appears to emanate from the **emotional connection** he feels with his chosen observation animal. During our first interview, he speaks about seeing damselfish while snorkelling and remembers when one fish swam directly into his hand:

> It jumped out of the water, and I held it. I put it back because it couldn't breathe. (Gary, Grade 5 LN, interview, February 16, 2004)

Gary views his emotional connection as a deep friendship. He tells me that when he released the fish, he felt that he "made a friend for life", and the experience inspires him to choose the damselfish for his WaterWorlds observation animal (interview, February 16, 2004). Gary's emotional connection is sustained and furthered through the programme and is evident in his desire for his family to meet his damsel:

> I will come with my family to show my damselfish. They can meet him. I talk about him at home every night. (Gary, Grade 5 LN, interview, May 25, 2004)

Although Gary's ethic of care is seen primarily in the observation animal relationship, he shows his developing environmental caring during other activities. Gary extends his ethic of care to incorporate a more environmental focus and a global message of 'preserve nature as it is.' For example, after participating in the trainer tour, he expresses his delight in "just watching Tanu swim" rather than "training" him (interview,

May 25, 2004). When I ask him about his feelings he states "Well I think Tanu is beautiful. Like in the wild, just living you know, no people telling him what to do" (interview, May 25, 2004). Gary's feelings of care extend to all species and believes even animals regarded as 'pests' like the bullfrog have the right to live "even though they eat other frogs and shouldn't" (interview, February, 20, 2004). Gary provides evidence of an enduring environmental ethic of care and emotional connection when he later reflects on his experiences:

> My damsel was the best. They are beautiful, and I love it! And it's peaceful ... like me. Peace and no fighting. (Gary, Grade 5 LN, interview, May 25, 2004)

Gary begins WaterWorlds with environmental advocacy which he builds upon through the week. In our first interview, Gary tells me he learned about damselfish conservation while completing a pre WaterWorlds research project at school. He compiled information from internet searches, books, and fact sheets supplied by Diane. During our conversation he mentions environmental problems affecting damselfish such as "oil", "garbage in the water" and "too much fishing" (interview, February 16, 2004). As Gary experiences the programme, he expands his advocacy to include other animals. He learns that sea lions like Tanu are disappearing due to "not much herring left", that sharks are endangered because "people kill millions of sharks, but they kill not many people", and that the over-success of certain non-indigenous species can be harmful to biodiversity. For example: "bullfrogs eat other frogs which isn't good" (interview, February 20, 2004). Post WaterWorlds, his environmental advocacy culminates in a **plan for action** that, as he explains, would help his damsel:

> I would put damselfish on TV ... in a short movie .., I would say that the damselfish need our help and so does their home. (Gary, Grade 5 LN, interview, May 25, 2004)

Gary's movie will also feature a group of damselfish united in their quest to find family and friends lost to hunters who catch them for sale to pet stores:

> You know like in Finding Nemo (movie). The fish look for damsels who were taken by divers with nets. (Gary, Grade 5 LN, interview, May 25, 2004)

Gary finds it challenging to communicate his ideas in writing, thus when I review his journal for evidence of his engagement in and response to the programme, I find few words and phrases, accompanied by a profusion of damselfish drawings and illustrations of other animals including wet lab invertebrates, sea lions, sharks, and frogs. While drawings help Gary communicate ideas he cannot articulate, these pictorial accounts still reveal only part of Gary's story. His personal narratives provided during our conversations and interviews together with his journal entries speak to Gary's growth in environmental knowing that emanates from gains in his environmental knowledge, refinement in his ethic of care to incorporate an environmental focus, and growth in his capacity for environmental advocacy and action.

Researcher Reflections

The WaterWorlds experiences of Claire, Oliver, Faith, and Gary provide an in-depth look at different ways children engage in and respond to the WaterWorlds programme. Through participation in the week's activities, the children gained environmental knowledge and developed an ethic of environmental care, environmental advocacy, and commitment to action. Current research on effective environmental education curricula advocates that children are more engaged and develop knowledge, caring, and commitment during experiential field based programmes (Hungerford & Volk, 1990; Jickling, 2003b, 2005; Kellert, 2002; Payne, 2005; Sobel, 2004) that focus

on changes in knowledge, attitudes, and behaviour (Hart, Jickling, Kool, 1999; Hungerford, Peyton, & Wilke, 1980; Marcinkowski, 2001; Winther, 2001). Researchers find that when children forge close relationships with other animals through prolonged engagement and study they develop caring and commitment that may extend to other species and lead to global world views (Fawcett, 2003; Mortari, 2004; Sobel, 2004; Vining, 2005). The children's stories presented here support this research and provide evidence of the significance of WaterWorlds experiences including Animal Observations, the Wet Lab, Expert Talks, and Artefacts in fostering their environmental knowing.

Animal Observations provided the children with a foundation for developing caring, connection, and commitment for aquatic animals. Claire came to view her animal as an extension of herself. She discovered that she and Vinegar were "a lot alike" and described herself and the seahorse as "late crowd joiners". Like Claire, Oliver's relationship with his animal eased feelings of loneliness and isolation as the reef shark reminded him of his former home in South Africa. The odes created by Claire and Oliver illustrate the knowledge and emotions evoked by their observation animal experiences. Claire's words reflected both her seahorse's and her own solitary existence and quest for friendship. Oliver's ode combined appreciation for the shark's "aggressive" nature and "stealthy" moves with concern for the over harvesting of a species he described as a "best friend". Gary expressed his knowledge, appreciation, caring, and concern for his animal through drawings and dialogue rather than writing. He regarded the damselfish as a kindred spirit who shared his pacifist views and values of "peace and no fighting".

Faith bonded with her animal, the white sturgeon, even though it was not her first choice. She came to appreciate the fish for its "mystery" and detected elements of her grandfather in the sturgeon's grizzled appearance and "grumpy" behaviour.

Expert Talks with Centre staff provided a venue for thinking, dialogue, communication, discussion, and reflection. During the talks, the children honed their communication skills by observing, listening, drawing, writing, and asking "powerful" questions. They were introduced to research studies and conservation initiatives taking place at the marine science centre and also learned about ways they could "help" aquatic animals and their environment. The experts who gave the talks became role models and mentors for the children as they demonstrated and explained their work as trainers, aquarists, researchers, and educators. Both Claire and Faith expressed interest in becoming marine biologists and marine mammal trainers after participating in Expert Talks. Before meeting the sea lions and their trainers, Oliver anticipated "seeing ... sharp teeth in action", but by the end of the experience he wondered about the mammal's communication methods and ability to digest bones. After his afternoon with an expert herpetologist, Gary understood the initiative to eliminate the "alien bullfrog" to conserve indigenous amphibian species but maintained his conviction that "bullfrogs should live too".

Artefacts enabled the children to combine their existing knowledge with WaterWorlds experiences and employ their senses to examine, discover, and explore. The assortment of jaws, skins, teeth, and furs provided a context for investigating different species and biological classification, adaptations, and protection strategies. The children also incorporated their prior knowledge, culture, values, and ideas about

conservation into their Wet Lab experiences. The sea otter pelt reminded Claire of seeing the mammals "wrapped in kelp" during a family fishing trip. Oliver was initially drawn to the "mean" and "vicious" looking piranha jaw, but his writing focused on the tactile sensation of the "soft" and 'warm" sea otter pelt and the mammal's near extinction due to the fur trade. The abalone shell prompted Faith to explain that the "big" abalone are disappearing, and the "little ones" must be allowed to "grow up" and repopulate the species. Gary focused on artefacts that appealed to his senses such as shark jaws and skins. His conversations and illustrations reflected his valuing of the colours and patterns of the natural world.

The Wet Lab provided the children with a multi-sensory experience as they touched and interacted with living animals. As the children studied crabs, sea anemones, octopus, and seastars in situ, they developed classification criteria, investigated adaptation and feeding strategies, observed the 'real life' drama of predator prey relationships, and learned about the effects of human action on ocean biodiversity. Claire developed knowledge through touching, face-to-face observation, and acquiring information through conversations with Diane, her teachers, and wet lab volunteers. Oliver's explorations focused on the "toughness" and "big pincers" of crabs but also involved noting similarities between himself and the crustacean. Faith brought her knowledge of collecting crabs and clams for food to her Wet Lab experiences and also became an advocate when she reminded classmates about the "pinkie rule". Gary delighted in the tactile sensations of the "sticky anemone" and "all the colours" of the different wet lab residents.

The stories of Claire, Oliver, Faith, and Gary and the vignettes and table data from the two previous chapters show that over time the interdisciplinary, multi-sensory, and multi-disciplinary WaterWorlds experiences informed and enhanced children's environmental knowing. As they participated in WaterWorlds, children chose the ways they interpreted and expressed their environmental knowledge, ethic of environmental care, environmental advocacy, and commitment to action. This development of each individual child's self-expression resulted in motivational and powerful learning experiences that inspired, developed, and nurtured their environmental knowing.

CHAPTER SEVEN

SUMMARY, FUTURE RESEARCH, AND CONCLUSIONS

My research investigated children's experiences in WaterWorlds an environmental education programme taking place at a marine science centre. I analyzed the ways WaterWorlds activities informed the children's environmental knowing by exploring changes in their environmental knowledge, ethic of environmental care, and their advocacy and commitment to action regarding the environment. My analysis of the children's engagement in and responses to WaterWorlds indicated that they developed a broad range of environmental understandings and commitment to action during the programme and post experience. My analysis of four children's WaterWorlds stories revealed that their programme experiences informed their environmental knowing through gains in environmental knowledge, and development in their ethic of environmental care, environmental advocacy, and commitment to action for the environment.

In this chapter I summarize my research findings by revisiting the questions that guided my study.

1. How do children understand and interpret their experiences in an environmental education programme at a marine science centre?
2. How do the experiences in the programme foster environmental knowing among the children?

I also discuss the implications of my research findings and make suggestions for further research.

Summary

To study children's experiences, I accompanied four classes of elementary children as they participated in WaterWorlds, a field-based environmental education programme. The children took part in five sequential days of experiential activities including Animal Observations, the Wet Lab, Expert Talks, and gallery activities such as writing and performing animal odes. I assessed their engagement and response to the week's experiences by analyzing their environmental understandings and actions in the interview, observation, and document data. In addition to analysing the experiences of 54 children, I also examined the cases of four individual children to provide an in depth look at children's environmental learning in WaterWorlds. My findings are presented below.

Research Question 1: How do children understand and interpret their experiences in an environmental education programme at a marine science centre?

Children expressed their environmental understandings and commitment to action in terms of environmental science, aesthetics, ethics, and history. An environmental science focus was evident in children's responses that focused on issues of ecology, physiology, taxonomy, biodiversity, science education, and scientific research. Children who adopted an aesthetic lens of understandings and commitment to action used artistic, spiritual, sensory, and emotional forms of communication to present their programme experiences. The theme of environmental ethics was seen in responses that focused on issues of conservation and consumerism. Historical understanding was evident when students viewed their programme experiences in terms of culture, community, global concerns, and personal experience.

Children's participation in the programme was associated with development of a range of environmental understandings and commitment to environmental action. At the beginning of WaterWorlds the children focused on environmental understandings they brought with them to the programme. These understandings were based on existing knowledge of the environment and their experiences with their culture, their family, and their community. As they participated in the programme the children augmented and enhanced their environmental understandings, became environmental advocates, and developed a commitment to action for WaterWorlds animals. Some children adopted a worldview that included concern for the ocean environment as a whole and demonstrated a burgeoning awareness of all the earth's communities. Children's commitment to environmental action grew throughout the programme and continued after the programme ended.

Individual children responded to the different programme experiences in different ways. This illustrates the importance of providing children with a multi-dimensional environmental education experience. Through her participation in WaterWorlds, Claire learned to see, appreciate, and value the small and large creatures in the ocean and to adopt new approaches to learning through careful observation, first hand experience, asking questions, and reflection. Oliver initially understood and interpreted his WaterWorlds experiences through a scientific knowledge lens, but as he engaged in activities he developed connection, caring, and concern for the ocean environment. Faith brought her experiences of First Nations culture, community, and family to WaterWorlds and her existing knowledge informed and enhanced her programme experiences. Gary's viewed his WaterWorlds experiences through a multi-sensory lens, and his engagement

in and responses to the week reflected his pacifist heart and mind. He found written communication challenging, and even his pictorial accounts revealed only part of his WaterWorlds story. It was through the personal narratives he provided during conversations and interviews together with his detailed drawings of marine animals that Gary revealed his deep response and engagement to WaterWorlds experiences.

Research Question 2: How do the experiences in the programme foster environmental knowing among children?

Through their participation in the WaterWorlds environmental education programme, children developed environmental knowing that encompassed environmental knowledge, the development of an ethic of care, an understanding of environmental advocacy, and a commitment to action for the environment. The WaterWorlds week encompassed diverse experiences that together informed the children's environmental knowing through multi-disciplinary, multi-sensory, and interdisciplinary activities encompassing environmental science, aesthetics, ethics, advocacy, and action.

Through the Observation Animal experience, the children forged a connection with a WaterWorlds animal that evolved to include caring and concern for other animal species and the ocean environment as a whole. The stories of Claire, Oliver, and Faith also reveal that for these children, the observation animal relationship became the nucleus of their WaterWorlds experiences and provided a focus and impetus for their environmental knowing. Claire's story exemplifies the strong bond children feel for the observation animal. She comes to view the seahorse she named Vinegar as an extension of herself and believes they both share feelings of isolation and are "late crowd joiners".

Oliver's story shows that although he was knowledgeable about sharks prior to WaterWorlds, he developed caring and advocacy for his individual animal and shark species worldwide. His relationship with the "dominant female" shark also helped ease feelings of loneliness and homesickness. Faith's story reveals that even relationships with non-charismatic animals can inform children's environmental knowing. For Faith, the sturgeon inspires caring, connection, and a commitment to action that reflects her knowledge of, and experiences with, family and First Nations culture. Gary views his observation animal as a kindred spirit as the damsel supports and strengthens his "peace and no fighting" values. For Claire, Oliver, Faith, and Gary the observation animal becomes the focal point and inspires their burgeoning environmental knowing. As each child bonded with their animal they gained environmental knowledge and developed an ethic of environmental care, environmental advocacy, and a commitment to action for the environment.

The Wet Lab experience provided children with the opportunity to touch, explore, and study local invertebrate species. As they interacted with wet lab residents the children directly observed animal adaptations, behaviour, feeding strategies, and predator-prey relationships. Through conversations with wet lab staff, they learned about the fragility of the intertidal world and the effect of human actions on ocean biodiversity and ecosystems. Claire developed knowledge through touching, face-to-face observation, and information acquired during conversations with Diane, her teachers, and wet lab volunteers. Oliver's explorations focused on the "toughness" and "big pincers" of crabs but led him to recognize similarities between himself and the crustacean. Faith brought her knowledge of collecting crabs and clams for food to her Wet Lab experiences and

also became an advocate when she reminded classmates about the "pinkie rule". Gary delighted in the tactile sensations of the "sticky anemone" and "all the colours" of the different wet lab residents.

Expert Talks with Centre staff provided a venue for thinking, dialogue, communication, discussion, and reflection. During the talks, the children honed their communication skills by observing, listening, drawing, writing, and asking their own "powerful" questions. They were introduced to research studies and conservation initiatives taking place at the Centre and also learned about ways they could "help" aquatic animals and their environment. The experts who gave the talks became role models and mentors for the children as they demonstrated and explained their work as trainers, aquarists, researchers, and educators. Both Claire and Faith expressed interest in becoming marine biologists and marine mammal trainers after participating in Expert Talks. Before meeting the sea lions and their trainers, Oliver anticipated "seeing ... sharp teeth in action". By the end of the experience, ecological and physiological issues concerned him as he wondered about the mammal's communication methods and ability to digest bones. After his afternoon with an expert herpetologist, Gary understood the initiative to eliminate the "alien bullfrog" to conserve indigenous amphibian species but maintained his conviction that "bullfrogs should live too".

Artefacts enabled the children to combine their existing knowledge with WaterWorlds experiences and employ their senses to examine, discover, and explore. The assortment of jaws, skins, teeth, and furs provided a context for investigating different species through the study of biological classification, adaptations, and protection

strategies. The children also incorporated their prior knowledge, culture, values, and ideas about conservation into their experiences.

In summary, this study shows that through their participation in WaterWorlds children gained environmental knowledge and developed and refined their ethic of environmental care, environmental advocacy, and commitment to environmental action. WaterWorlds informed and supported the children's acquisition and growth of environmental knowing through multi-disciplinary and multi-sensory experiences such as Expert Talks, the Wet Lab, Artefacts, and Animal Observations. When viewed together, the individual stories of Claire, Oliver, Faith, and Gary reveal that the observation animal provided the nucleus for the children's environmental knowing. As the children experienced "co-feeling" (Noddings, 2005) for their animal, they forged a connection and developed natural caring and commitment for the earth.

Emergent Issues

This thesis focused on two research questions that examined children's environmental education experiences and their environmental knowing. As this study unfolded however, some issues emerged that I believe warrant further consideration and comment. Gender was one such issue. My data revealed that boys and girls responded to WaterWorlds in interesting ways. The children's conversations and work at the beginning of WaterWorlds support educational research that suggests young learners are attracted to certain species of animals (Kellert, 1999, 2002; Barney, Mintzes, & Yen, 2005). Studies also find that boys hold a utilitarian (practical, material, and physical) view of animals whereas girls are more protectionist, preservationist, and place a greater

emphasis on advocacy (Czech, Devers, & Krausman, 2001; EETAP, 2000; Van Velsor, 2004; Zelezny, Chua, & Aldrich, 2000). I observed that at the beginning of the programme boys and girls focused on WaterWorlds animals that they described as "active", "athletic", "beautiful", or "ferocious". Faith and Oliver both chose to study "charismatic megafauna" such as dolphins and sharks (Kellert, 1999, 2002; Barney, Mintzes, & Yen, 2005). Yet, gender differences emerged when the children expressed their feelings about WaterWorlds animals. Faith spoke about her aesthetic appreciation for and emotional connection with animals, and Oliver focused on the physical and behavioural characteristics of different species. I characterized Faith as a Dolphin Girl. She was initially drawn to animals, in this case Wings the dolphin, that were "cute" and "beautiful". She expressed concern for Wing's "loneliness" and advocates "finding him a mate" (Faith, interview, November 24, 2003). Oliver exemplified the Shark Boy. He gravitated towards the black tipped reef shark that he described as "ferocious" and "dangerous" (Oliver, interview, January 12, 2004). He was well versed in shark facts and had some awareness of environmental problems affecting sharks but did not articulate his feelings or emotions for the species.

I found that these gender differences diminished over the week as Faith and Oliver focused less on their initial conceptions and concentrated more on direct experiences with WaterWorlds animals. Faith observed the "scary" sturgeon which she later described as "mysterious" and compared the fish to her grandfather (Faith, interview, November 28, 2003). Oliver remained a Shark Boy but extended his focus to praise his animal's "elegant engineering" and agility. Rather than describe the fish's

fearsome reputation in his ode, he lamented the loss of "100,000,000" sharks a year (Oliver, Journal, Ode, January 16, 2004).

Faith and Oliver's initial engagement in and response to WaterWorlds also support research that finds boys' understanding of environmental education activities tends to be primarily based on facts and science whereas girls concentrate more on feelings (EETAP, 2000; Kellert, 2002; Kellert & Berry, 1987). Oliver came to WaterWorlds talking about shark facts, whereas Faith began the week expressing her "love" for Wings the dolphin. Yet again, the children's stories show that this demarcation became less pronounced as they engaged in five days of field experiences, and by the end of WaterWorlds, both Faith and Oliver made an emotional connection with and showed feelings for their observation animal. In his ode, Oliver described his shark as a "good friend" (Oliver, Ode, January 16, 2004), and his father told me that the relationship helped Oliver adjust to moving from South Africa. Faith grew to "love" her sturgeon as she compiled data on the fish's life history, behaviour, and physiology (Faith, interview, November 28, 2003).

A final note on WaterWorlds experiences and gender differences addresses my designation of Shark Boys and Dolphin Girls. As mentioned in an earlier chapter, I found that Shark boys like Oliver were attracted to the fish's aggressive reputation, and Dolphin Girls like Faith "loved" their mammal's "cuteness", beauty, and grace. It is interesting however that when I asked Faith why she did not choose the shark as her observation animal she replied that there were "Too many boys at sharks!" (Faith, conversation, February 12, 2004).

My conversations with and observations of Faith and Oliver suggest that boys and girls may choose WaterWorlds observation animals based on their sense of gender identity. On her first day of WaterWorlds Faith noticed that other girls, including her three friends, were with the dolphin. By choosing to observe the dolphin with them, she was able to remain with like-minded companions of her 'gender community'. The boys exhibited a similar gender identity. Oliver and his friends, like many boys at WaterWorlds, formed a community of Shark Boys, and they observed, discussed, and reflected upon their shark experiences together. Faith was a special kind of Dolphin Girl as she was able to leave the 'comfort zone' of the Dolphin Girls and connect with the sturgeon. Oliver was also unique. He remained a Shark Boy, but his focus changed from exalting the animal's "ferocious" characteristics to praising the grace and agility of his observation animal, the "dominant female" shark.

Another emergent issue that warrants further discussion concerns the experiences of the First Nations children who participated in this study. I found that Faith's engagement in and response to her experiences reflected her connection with indigenous culture, family, and community. Researchers claim that indigenous children often have different understanding and ways of knowing the world (Barnhardt & Kawagley, 2005; Bowers, 1999; Cajete, 2000; Hansen & Van Fleet, 2003; Kawagley & Barnhardt, 2005; Snively & Corsiglia, 2001; Stephens, 2003). Faith's cultural background guided and informed her WaterWorlds experiences through beliefs inherited from family and "ancestors". Faith began WaterWorlds with a connection to the land and an understanding of the "shoulds" and "should nots" of human behaviour in the natural world (Cristancho & Vining, 2004, p.48). Faith's indigenous knowing was also reflected

in her conversations and stories. She spoke of salmon fishing and harvesting shellfish with her family, and during conversations with peers she emphasized the importance of collecting only large specimens as "you don't take baby ones" (Faith, conversation, November 25, 2003). She instructed her friends on how to handle crabs and reminded them about the "pinkie rule" during the Wet Lab. Faith also expressed awareness and concern for "disappearing" species such as the abalone. During Artefacts she explained the mollusc's importance as a traditional food source and the aesthetic and spiritual significance of the animal's iridescent shell.

Faith's story confirms claims made by scholars of indigeneity who write that indigenous learners know the world through a multi-generational understanding which emphasizes interconnectedness, adaptation to change, commitment to family, community, and culture, and a connection with place (Hansen & Van Fleet, 2003). Many indigenous peoples do not consider environmental education to be separate from education, and therefore for some the term 'environmental education' is an "unknown concept" (M.Tsepa, personal communication May 20, 2005). Geddes (1994) points out that First Nations peoples "would never have a subject called environmental ethics; it is simply part of the story" (p.32). Perhaps First Nations learners also understand environmental education to be "part of the story". For many 'people of the land', a tradition of understanding, caring, and protecting the earth is essential to the existence, health, well-being, and spirituality of individuals, family, community, and culture. Therefore First Nations children like Faith who have strong ties to their culture and community may view environmental education experiences as "simply" life experiences.

This study also provides ideas on the ways in which special needs learners engage in and respond to environmental education experiences. Gary and his LN classmates have delays in their English language skills, most notably in writing. Katcher (2002) conducted a study of learners with developmental disabilities (behavioural and verbal) and found that the participants became more socially interactive during direct experiences with zoo animals. The children also engaged more freely in dialogue, and those with behavioural problems were less aggressive with both adults and peers. The document and interview data for the LN class and Gary's individual story show that the LN children gained knowledge and developed an ethic of care and advocacy during WaterWorlds. The greatest development was in their commitment to environmental action. During the study, I found that many LN children preferred to talk about their experiences rather than write in their journals, and as in Katcher's (2002) study the children became more social and inclined to talk as they participated in the programme.

My study also adds to the research on place-based environmental education. Researchers state that children develop a sense of place during experiences that foster their environmental knowledge, caring, connection, and commitment for ecological, social, community, and cultural places (Gruenewald, 2005; Hart, 1997; Myers & Saunders, 2002; Sobel, 2004). I suggest that for Claire, Oliver, Faith, and Gary the observation animal became the 'place' that informed their environmental knowing and inspired them to connect with other animal species, the ocean realm, and the world beyond.

Researcher Reflections

In conducting this study I was aware I brought the lens of a white, middle class, educated woman to my researcher role. I endeavoured to portray and interpret the children's stories and represent each child in an unbiased way, but my words had limitations due to my socio-cultural background and personal beliefs. I strove to address these limitations through long term engagement with the children and my use of multiple data sources and unobtrusive data collection methods. In the end, all stories are open to interpretation, and I wrote this thesis with the purpose of presenting the children and their stories as authentically as possible.

Implications for Teaching and Learning Environmental Education

This study has implications for classroom teachers, environmental education practitioners, and educational institutions as the findings provide a link between environmental education theory and practice. My research provides empirical evidence of the kinds of multi-disciplinary and interdisciplinary experiences that inform children's environmental knowing through gains in knowledge and development in their ethic of environmental care, environmental advocacy, and commitment to action for the environment.

This study may benefit researchers and practitioners interested in understanding the value of implementing multi-disciplinary environmental education curricula. There is a lack of research on children's environmental education learning experiences (Hart & Nolan, 1999; Rickinson, 2001) and a need to examine the significance of curricula that advance and support the "doing" of environmental education.

This study may help practitioners in the creation and implementation of a multi-disciplinary and interdisciplinary environmental education curricula. Classroom teachers cite the need for concrete examples of environmental education and ask for ideas on lesson planning, thematic units, and curriculum placement (Jarnet & Marquis, 2001). My findings on the impact of the WaterWorlds experience may encourage educators to use this programme as a model for developing multi-disciplinary and interdisciplinary environmental education in both classroom and out of school settings.

This study's findings may also assist zoos, marine science centres, and other educational institutions that wish to develop environmental education programmes that incorporate children's experiences with other animal species. There is little information on children's environmental learning experiences particularly in aquarium and zoo settings. Thus, this study's findings may also prove beneficial to such institutions, particularly if they are interested in learners' environmental understandings and their agency regarding the environment.

Suggestions for Environmental Education Programmers and Practitioners

My research reveals that environmental education programmes may benefit from incorporating experiences that address and value the different ways children know the world based on their prior knowledge, ages and developmental stages, socio-cultural background, and learning needs. Claire's story illustrates that some older children may not begin a programme of experiential environmental education with the same excitement and enthusiasm as younger learners. For Claire, the observation animal provided sufficient motivation for her to engage fully with, and benefit richly from, the week's

events, but there were other older students in the programme who did not respond as positively to the WaterWorlds experience. During the post WaterWorlds interviews two Grade 7 boys from the Language Needs class, Theo and Herb, declared their week to be a "waste of time", "not fun", and both concluded that they "would never do it again" (interview, Theo and Herb, LN, Grade 7, interview, May 25, 2004). Although these two boys' responses are not the norm for WaterWorlds participants, they indicate that educators may need to seek other ways to inspire and engage less enthusiastic students in environmental education. For example, providing learners with the opportunity to create and implement their own activities or inquiries may enable students to take ownership of some events and benefit more fully from all five days of experiences.

Theo and Herb also echoed the sentiments of many of the LN students from both the Grades 4/5 and 6/7 classes when they expressed their dislike for "writing in the journal" (interview, Herb and Theo, May 25, 2004). For WaterWorlds participants who experience difficulty in documenting their experiences through writing, perhaps in addition to their journal, they could chronicle their week through alternative strategies such as video, photographs, audio-taped conversations, artwork, and the performing arts.

I also found that most of the LN children valued the interview process as they enthusiastically informed me not only about WaterWorlds experiences but their lives, family, pets, and friends. At the conclusion of one interview, Chris, a Grade 6 LN student asked, "Anything else you want to know about me?" (interview, May 26, 2004). Based on the LN children's responses, I suggest that interviewing children about their experiences could be an effective way to help them learn to express and articulate their

environmental knowing during the WaterWorlds programme. Interviews could also be used as an assessment tool by teachers and programme instructors.

This study also shows that environmental education programmes would greatly benefit from incorporating participants' rich and diverse socio-cultural backgrounds. Faith's story portrays how her indigenous knowing informs her WaterWorlds experiences. She began the week with a knowledge of, caring about, and advocacy for the land inherited from her First Nations family, community, and culture. Faith also expressed her responses to WaterWorlds through ways that reflect the oral traditions of her culture such as conversation and storytelling. Based on Faith's story, I suggest that including and highlighting different perspectives through experiences such as Expert Talks with Elders and storytelling may encourage environmental programme participants to value and appreciate the knowing of other cultures and ultimately adopt a more global worldview in their own ways of knowing.

While this study shows that WaterWorlds experiences informed children's environmental knowing, I found that many programme experiences focused primarily on building environmental knowledge, specifically scientific knowledge. Children's environmental caring, advocacy, and commitment to action were developed primarily through the observation of animal relationships, and I noted that children offered action ideas only when I asked about how they might "help" their observation animal. As they progressed through their week, the children learned about environmental problems and different conservation initiatives predominantly during Expert Talks and the predator/prey demonstration during the Wet Lab. Other programmed activities provided little or no information on ways to effect positive change to help the environment.

One way that WaterWorlds and other environmental programmes could assist children in developing commitment and ultimately taking environmental action is to inspire them to think about what they can do at home, in school, and within the community to help their observation animal, other species, and the earth as a whole. This could be done through implementing activities that involve scientists, educators, and conservationists dedicated to and active in caring for the earth. Encouraging and informing participants about the physical 'doing' of environmental action and introducing them to role models who make a difference by taking informed action may help to inspire and sustain participants' environmental knowing during the WaterWorlds week and beyond.

Future Directions

While this study offers qualitative evidence of multi-disciplinary and interdisciplinary environmental education experiences that inform children's environmental knowing, there are issues that merit further investigation. For example, my findings that gender plays a role in how participants engage in and respond to environmental education experiences suggests that further research is warranted. Boys and girls could be interviewed before their participation in, as well as during, and after the programme to determine similarities and differences in their engagement and response to experiences and how gender may influence their environmental knowing over time.

Another area that requires further investigation is the way in which indigenous learners engage in environmental education programmes. This would involve studying

children's cultural background, existing knowledge, and experiences before they participate as well as during and after the programme. I also believe that studying children with developmental disabilities and their environmental education experiences is another potential research area. My findings that many LN participants preferred to talk about their experiences rather than write in their journals could be explored further by investigating ways children interpret and express their experiences through conversation, discussion, drawing, performance, interviews, and other non-writing based modalities.

The more limited engagement and response shown by some older participants in Grades 6 and 7 indicates an area where further research is needed. It would be interesting to investigate what happens when we encourage children to create and implement their own ideas on programme experiences, and to explore having children who have already experienced the programme become guides and facilitators and act as 'buddies' and mentors for younger participants.

Another area that requires further investigation is the children's commitment to action. Children spoke of action plans that included creating websites, writing and illustrating books, and composing songs about their observation animals. Providing children with the required skills, materials, and guidance and conducting a study on how they create and enact their plans offers many rich research possibilities.

Environmental education practitioners including classroom teachers and programme coordinators and instructors like Diane play an important role in creating and implementing curricula. More research is needed to understand practitioners' experiences bridging classroom learning and out-of-school experiences. We need to understand teachers' views on how to link the theory of 'good' environmental education

with the practice of multi-disciplinary experiences, and the place of these activities within school curricula. An area of significance for all educators, in classrooms and field programmes, is how to assess and evaluate environmental education experiences, thus further research is also needed in this area.

Conclusions

This study of how children's participation in an environmental education programme informs their environmental knowing provides evidence of multi-disciplinary and interdisciplinary experiences that develop environmental knowledge, an ethic of environmental care, environmental advocacy, and commitment to action for the environment. Through engagement in activities such as Animal Observations, Expert Talks, the Wet Lab, and Artefacts the children connected with other animal species, expressed feelings of care and concern, became advocates for the environment and the earth's communities, and formulated action plans to help the natural world.

This study of WaterWorlds provides information on what is needed for experiential education. My research indicates that effective experiential education includes both cognitive and affective experiences and engages children in a variety of activities. These activities need to inspire children to ask questions, engage in inquiry, and pursue knowledge and skills in areas that are of personal interest to them. Children should take part in hands-on, face-to-face, and direct experiences, and have the opportunity to explore, share, interpret, express, and reflect upon their ideas in verbal and non-verbal ways. Successful experiential education is facilitated by knowledgeable and responsible educators who can model and encourage children to become part of a

community of learners. Experiential education provides learners with opportunities to draw from, value, incorporate, and build upon their prior knowledge, life experiences, and cultural backgrounds. An effective experiential education programme also requires a 'hook' (such as the observation animal) that provides a focus for in-depth exploration and discovery that leads to emotional connection, caring, and commitment.

My research presents WaterWorlds as one context for 'good' environmental education. My findings from this study support the view that 'good' environmental education is multi-disciplinary and interdisciplinary as it incorporates science, aesthetics, ethics, and history, involves the development of skills, knowledge, caring, and commitment, and follows a goal of informed and responsible action. Environmental education programmes that incorporate observation, study, research, writing, and reflection; involve direct interaction and prolonged engagement with other animal species; and follow an experiential field-based curriculum created and implemented by informed adults who act as role models and mentors, appear to inform and enhance children's environmental knowing of other species, communities, environments, and the world beyond.

Children engage in and respond to experiences in different ways, and their environmental knowing is shaped and enhanced by programme activities together with their prior knowledge, socio-cultural backgrounds, gender, and their ages and stages of development. This study of children's experiences highlights elements of environmental education that can inspire and inform participants' environmental knowing through a knowing of themselves, other species, environments, and the interconnectedness and interdependence of all the earth's communities.

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APPENDIX A

Interview Questions

Protocol for Interview 1

1. How did you prepare for WaterWorlds?
2. What are you most looking forward to during WaterWorlds?
3. What will you record about your Water World experiences in you journal?
4. How will you record your Water World experiences in your journal?
5. Which animal did you choose for you observation animal? Why?
6. What did you know about your animal before the program?
7. Do you know about any survival problems your animal may have?
8. What do you think you could do to help your animal?
9. How might you "get the word out" to other people about your animal?

Protocol for Interview 2

1. Tell me about your observation animal?
2. Did you name your animal? Why?
3. What did you enjoy most about morning observations?
4. How did you record your observation animal experiences in your journal?
5. What did you record about your observation animal in your journal?
6. Have you learned about any survival problems that your animal may have?
7. How could you help your animal?
8. How might you "get the word out" to other people about your animal?

Protocol for Interview 3

1. How did you feel on the last day of WaterWorlds?
2. What was/were your favourite experience/s? Least favourite?
3. If you were to go back to the Centre what would be the first thing you would do?
4. How did you record your observation animal experiences in your journal?
5. What did you record about your observation animal in your journal?
6. How did you say goodbye to your animal?
7. What observation animal would you choose if you were to go to WaterWorlds again?
8. Do you know of any survival problems concerning your animal?
9. What would you tell people about your animal?
10. What do you think you could do to help your animal?
11. How might you "get the word" out about your animal to other people?

APPENDIX B

Tables 1 and 2 for Mariner, Oceanview, and Evergreen Students

Table B.1. Mariner Grade 4 Range of Expressions of Environmental Understandings (n=27)

		Day 1		Days 2-5		Post-experience	
THEMES	**Subthemes**	Interview	Documents	Interview	Documents	Interview	Documents
Science	behaviour	5	10	14	21	10	12
	ecology	9	5	20	12	19	12
	education	10	9	20	16	24	16
	naturalistic	17	24	22	25	23	24
	physiology	1	1	8	4	7	5
	research	7	2	11	3	1	5
	taxonomy	13	10	17	5	16	10
Aesthetics	anthropomorphic	15	10	17	19	15	17
	art	11	13	16	23	16	24
	emotions/feelings	14	12	22	18	20	19
	family	2	-	11	-	13	-
	friend	6	-	8	-	8	-
	narrative	2	3	19	10	20	13
	sensory	12	5	19	7	16	8
	spiritual	10	2	12	4	13	4
Ethics	conservation	4	2	25	12	24	22
	entertainment	14	22	4	6	1	4
	egocentric	7	9	4	1	3	5
	ethnocentric	14	5	25	20	24	22
	moralistic	10	5	20	20	23	23
	utilitarian	3	-	8	3	4	-
History	culture	1	1	4	5	4	6
	direct experience	21	22	24	23	19	15
	global	-	3	17	4	20	6
	local/community	3	-	9	2	9	3
	observation animal	-	10	16	21	19	25
	personal	14	14	9	11	5	9
	social	-	4	20	25	25	25

Table B.2. Mariner Grade 4 Range of Expressions of Commitment to Environmental Action (n=27)

		Day 1		Days 2-5		Post-experience	
THEMES	**Subthemes**	Interview	Documents	Interview	Documents	Interview	Documents
Science	ecology	3	3	20	16	20	17
	education	4	3	21	17	25	18
	physiology	-	-	2	7	3	5
	research	4	-	18	-	13	-
	taxonomy	-	-	2	-	3	-
Aesthetics	art	3	1	15	12	22	19
	drama	-	-	4	-	9	-
	music/song	-	-	-	-	3	-
	narrative	2	-	11	-	17	-
	persuasion	-	1	15	11	23	12
	video/technology	-	-	2	-	6	-
	web-site design	-	-	3	-	6	-
Ethics	conservation	4	7	16	11	21	12
	conservation education	1	5	17	12	25	12
	consumer	-	-	8	3	8	5
History	culture	1	-	2	-	2	-
	global	-	3	12	3	17	3
	local/community	1	-	7	2	8	4
	observation animal	-	7	18	10	24	9
	personal	-	-	10	-	7	-
	social	-	-	5	4	16	7

Table B.3. Oceanview Grade 6 Range of Expressions of Environmental Understandings (n=8)

		Day 1		Days 2-5		Post-experience	
THEMES	**Subthemes**	Interview	Documents	Interview	Documents	Interview	Documents
Science	behaviour	1	4	2	6	2	5
	ecology	-	1	1	2	1	3
	education	1	3	2	5	4	6
	naturalistic	2	3	3	6	6	8
	physiology	-	-	1	-	1	-
	research	-	1	1	1	1	2
	taxonomy	1	3	2	3	2	3
Aesthetics	anthropomorphic	1	1	2	3	2	2
	art	1	3	5	6	4	7
	emotions/feelings	1	-	3	3	4	4
	family	-	-	1	-	-	-
	friend	-	-	-	-	-	-
	narrative	-	1	4	3	6	4
	sensory	4	2	4	2	2	-
	spiritual	2	-	3	1	4	1
Ethics	conservation	-	1	2	2	8	7
	entertainment	2	2	-	1	-	1
	egocentric	3	1	2	1	-	-
	ethnocentric	1	4	4	7	5	7
	moralistic	1	2	6	4	6	5
	utilitarian	2	-	1	-	1	-
History	culture	-	-	-	1	-	1
	direct experience	6	7	4	5	4	7
	global	-	1	2	2	5	2
	local/community	1	-	1	-	1	1
	observation animal	1	2	1	5	1	6
	personal	1	4	1	5	1	6
	social	-	1	2	4	2	4

Table B.4. Oceanview Grade 6 Range of Expressions of Commitment to Environmental Action (n=8)

		Day 1		Days 2-5		Post-experience	
THEMES	**Subthemes**	Interview	Documents	Interview	Documents	Interview	Documents
Science	ecology	-	1	1	6	4	6
	education	-	1	3	6	5	6
	physiology	-	-	2	-	1	-
	research	-	-	1	-	3	-
	taxonomy	-	-	1	-	1	-
Aesthetics	art	-	1	4	7	6	5
	drama	-	-	-	-	1	-
	music/song	-	-	-	-	1	-
	narrative	-	-	4	-	6	-
	persuasion	-	1	3	1	4	3
	video/technology	-	-	2	-	6	-
	web-site design	-	-	-	-	5	-
Ethics	conservation	-	-	2	3	4	4
	conservation education	-	-	2	3	5	6
	consumer	-	-	2	-	3	2
History	culture	1	-	-	-	-	-
	global	-	1	2	2	5	2
	local/community	1	-	2	2	3	1
	observation animal	-	2	1	5	6	6
	personal	-	-	1	-	1	-
	social	-	2	-	4	1	6

Table B.5. Evergreen Language Needs Grades 4/5/6/7 Range of Expressions of Environmental Understandings (n=19)

		Day 1		Days 2-5		Post-experience	
THEMES	**Subthemes**	Interview	Documents	Interview	Documents	Interview	Documents
Science	behaviour	6	2	9	5	4	3
	ecology	3	2	10	3	10	3
	education	3	3	5	4	7	4
	naturalistic	8	-	8	2	12	10
	physiology	-	-	6	1	4	-
	research	-	-	2	1	2	3
	taxonomy	3	2	2	2	3	5
Aesthetics	anthropomorphic	3	1	9	5	5	4
	art	-	10	3	15	3	14
	emotions/feelings	4	2	4	4	13	7
	family	1	-	1	-	1	-
	friend	-	-	1	-	1	-
	narrative	-	-	-	2	3	5
	sensory	2	3	4	1	3	1
	spiritual	1	-	7	1	9	1
Ethics	conservation	2	-	2	-	5	4
	entertainment	7	5	6	3	2	3
	egocentric	1	1	2	5	4	-
	ethnocentric	2	1	10	9	13	7
	moralistic	1	-	11	3	10	9
	utilitarian	1	-	3	1	3	-
History	culture	1	-	4	-	3	-
	direct experience	1	3	11	9	12	7
	global	-	-	-	-	5	7
	local/community	-	-	-	-	2	1
	observation animal	-	-	11	9	15	6
	personal	1	2	9	8	12	7
	social	-	3	9	5	10	8

Table B.6. Evergreen Language Needs Grades 4/5/6/7 Range of Expressions of Commitment to Environmental Action (n=19)

		Day 1		Days 2-5		Post-experience	
THEMES	**Subthemes**	Interview	Documents	Interview	Documents	Interview	Documents
Science	ecology	2	-	1	1	8	4
	education	1	-	1	3	12	3
	physiology	-	-	1	-	4	-
	research	-	-	1	-	4	-
	taxonomy	-	-	1	-	4	-
Aesthetics	art	-	-	4	-	5	1
	drama	-	-	-	-	-	-
	music/song	-	-	-	-	-	-
	narrative	-	-	1	-	12	-
	persuasion	-	-	5	2	13	4
	video/technology	-	-	-	-	9	-
	web-site design	-	-	1	-	8	-
Ethics	conservation	-	-	11	4	13	6
	conservation education	-	-	9	5	12	5
	consumer	-	-	1	-	6	2
History	culture	-	-	-	-	4	-
	global	-	-	-	-	8	4
	local/community	-	-	-	-	3	3
	observation animal	-	-	-	-	14	6
	personal	-	-	-	-	12	-
	social	-	-	-	-	9	2

APPENDIX C

Documents

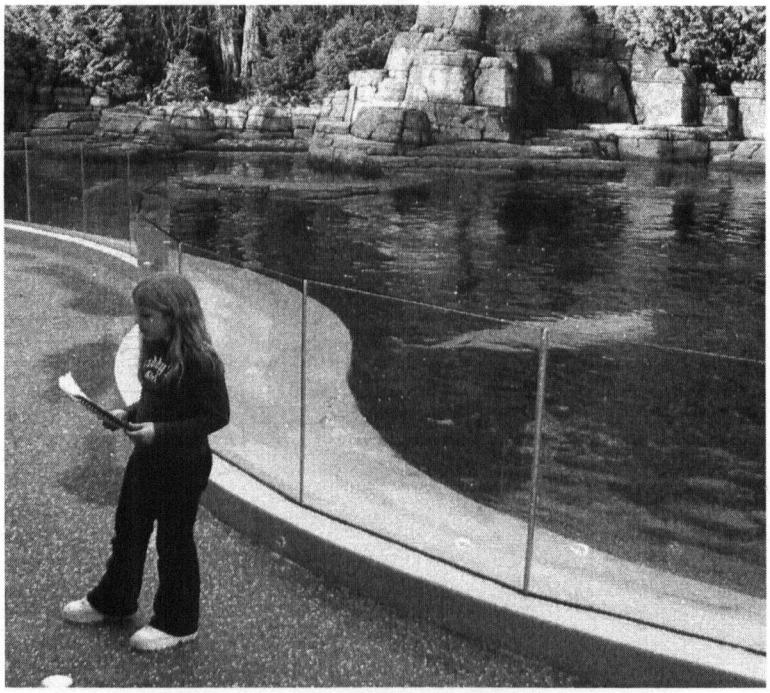


Figure C.1. Performing the Odes: Oceanview Elementary

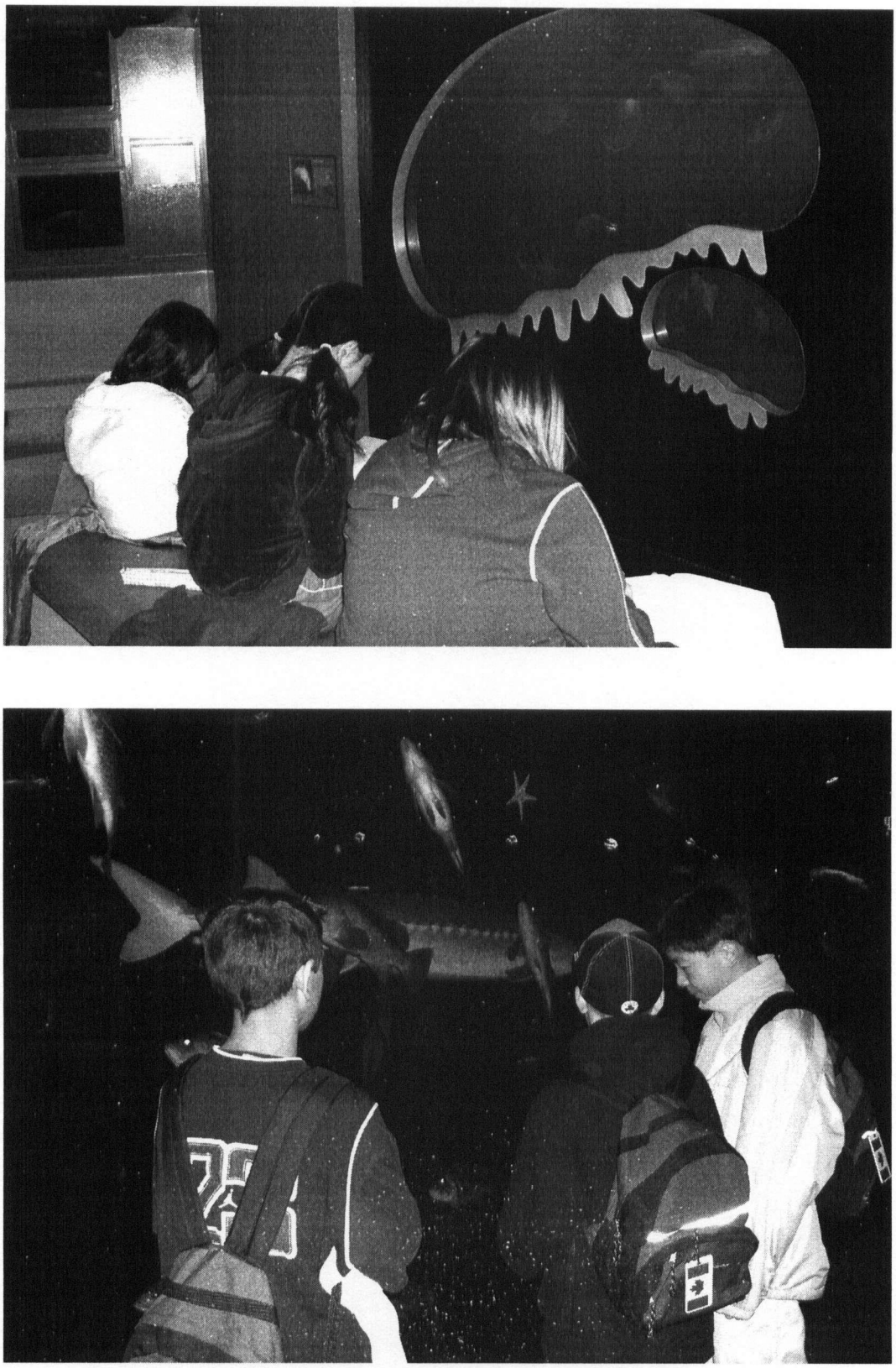
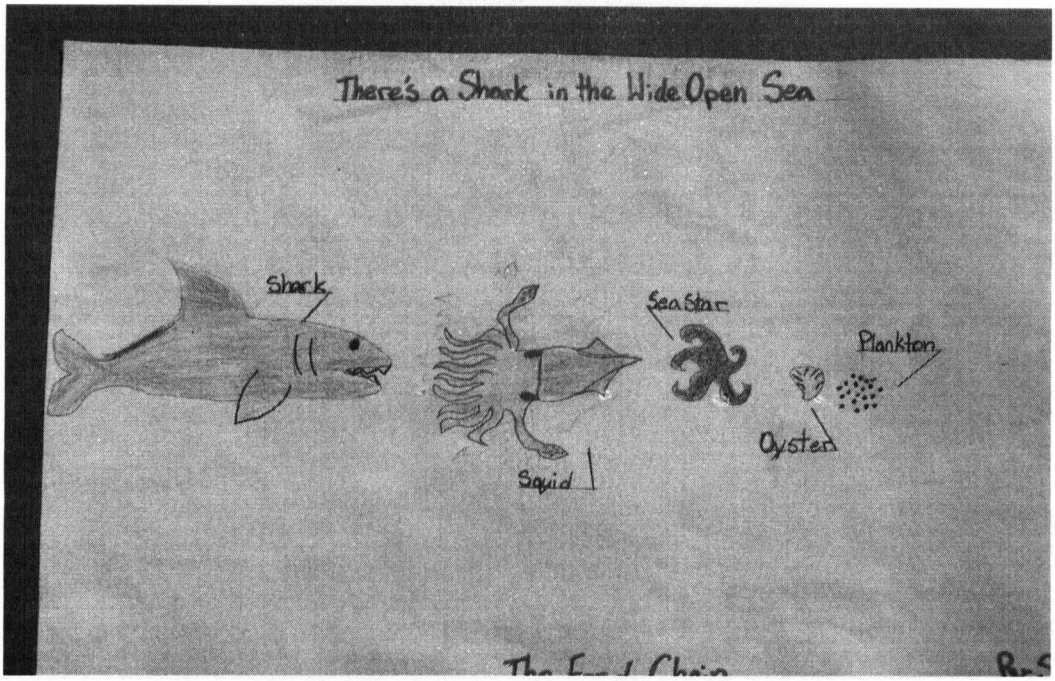


Figure C.2. Animal Observations: Evergreen Elementary

Figure C.3. Animal Observations: Oceanview Elementary

Figure C.4. The Wet Lab: Oceanview Elementary



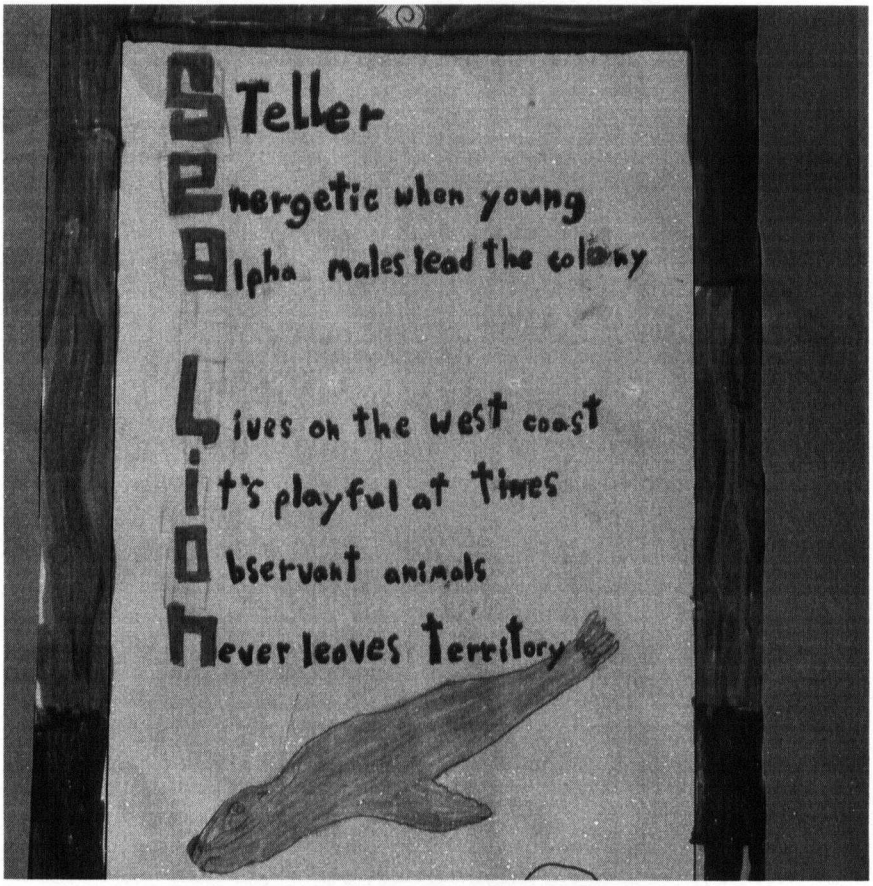
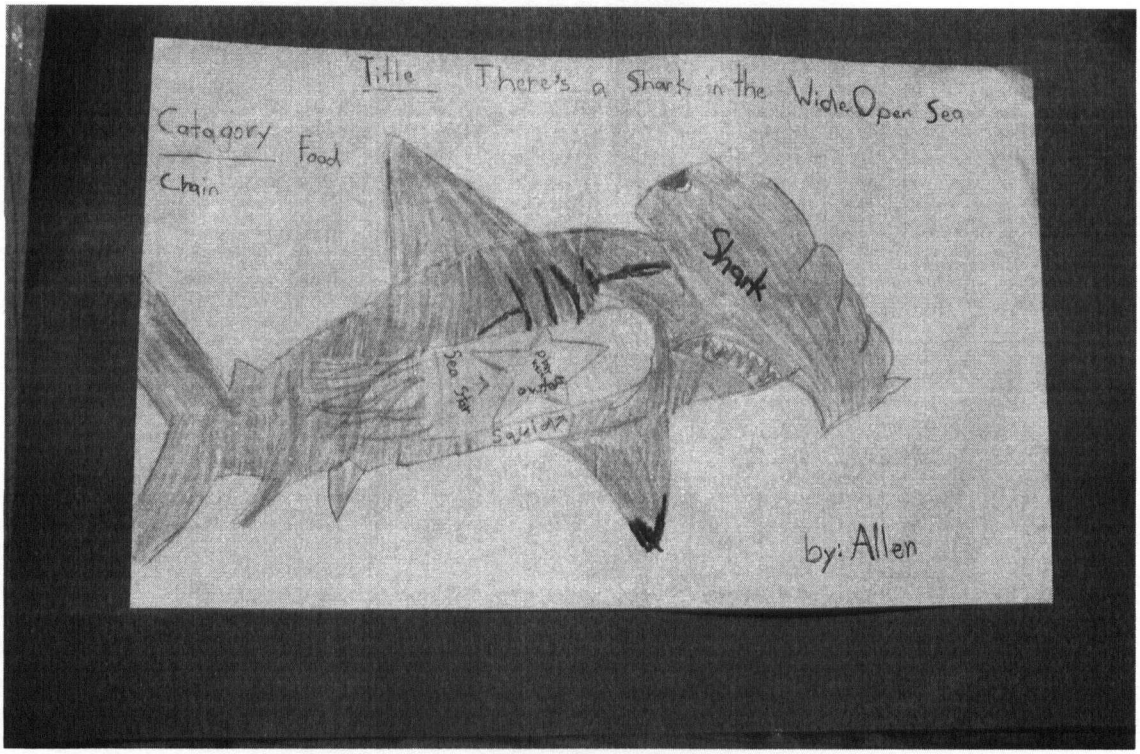


Figure C.5. WaterWorlds Work: Mariner Elementary



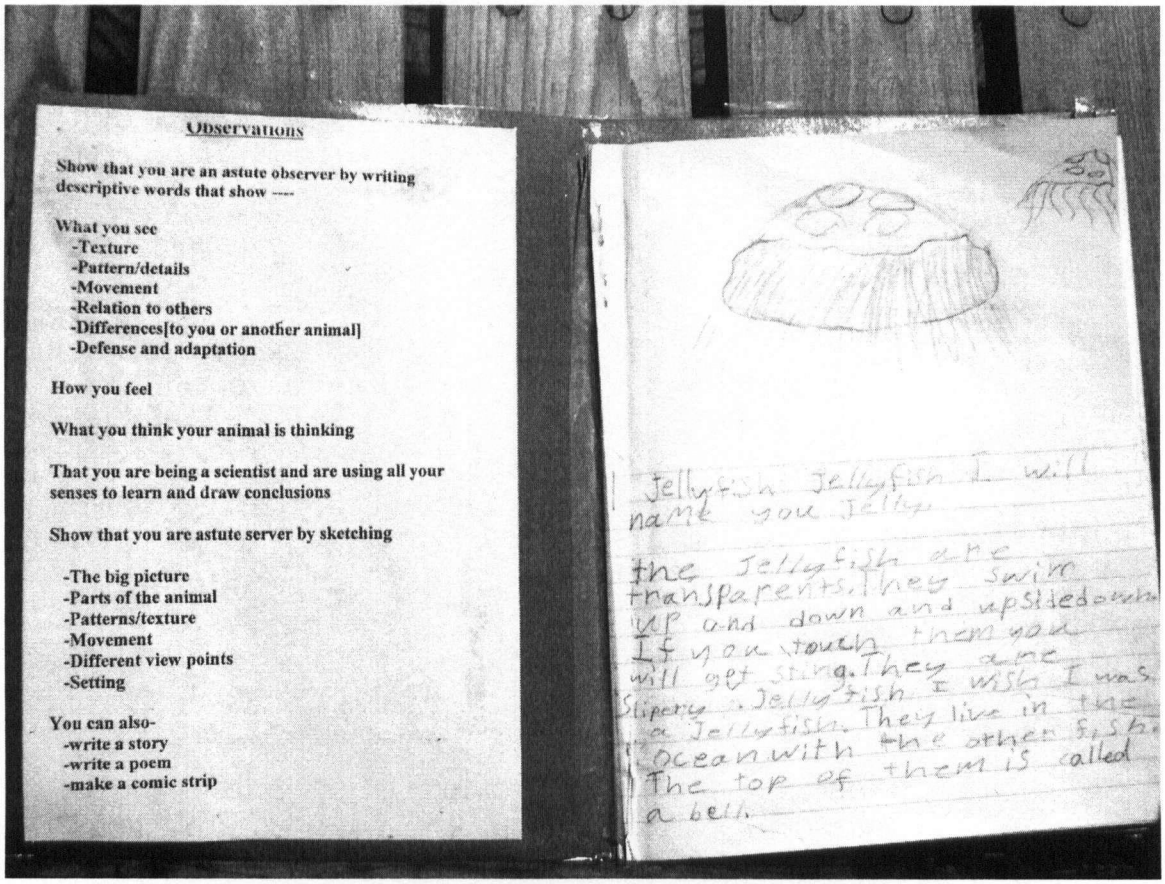


Figure C.6. WaterWorlds Work: Mariner Elementary

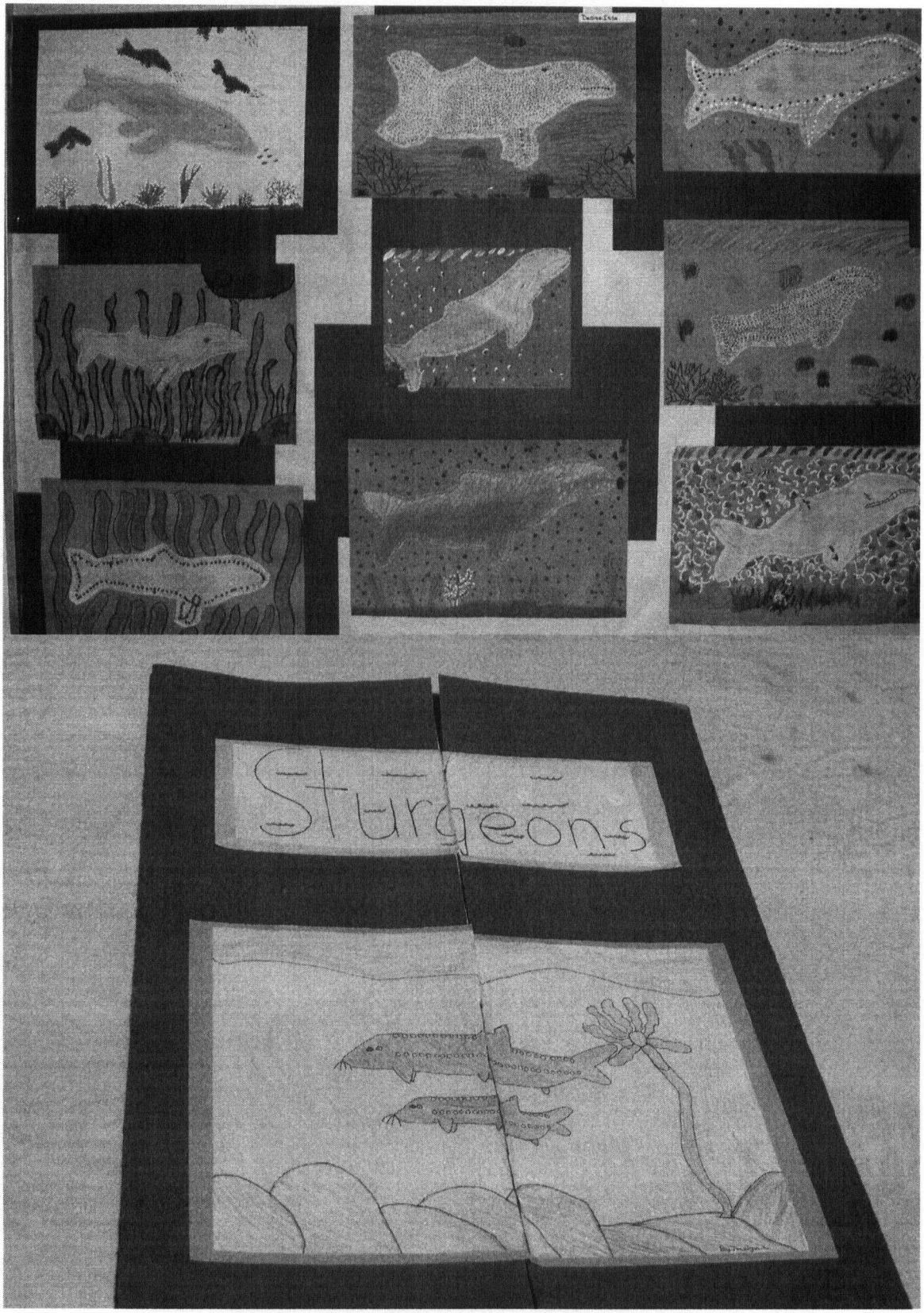


Figure C.7. Post WaterWorlds Work: Mariner Elementary

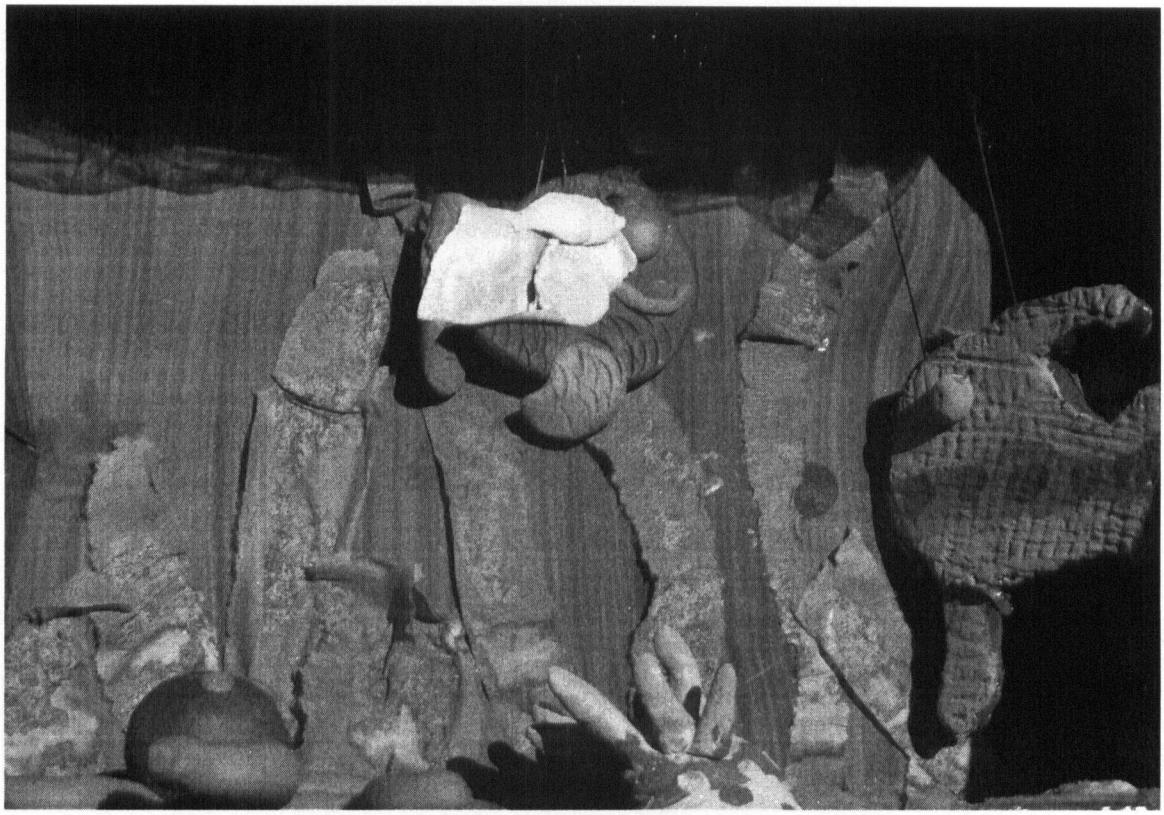


Figure C.8. Diorama: Mariner Elementary

I learned that belugas eat squid, worm, fish and shellfish. their enemies are Polar bears, Killer whales and humans. They like blowing rings and then putting their heads through them. Instead of a dorsal fin they have a row of bumps on there back. They are also endangered.

When we were leaving I felt sad because I was attached to the belugas. I did not want to leave them. They are the best animal I have ever liked.

When we came back we did t. shirts, dioramas and research. We celebrated did a song and skit.

Figure C.9. Thank You Letter: Mariner Elementary

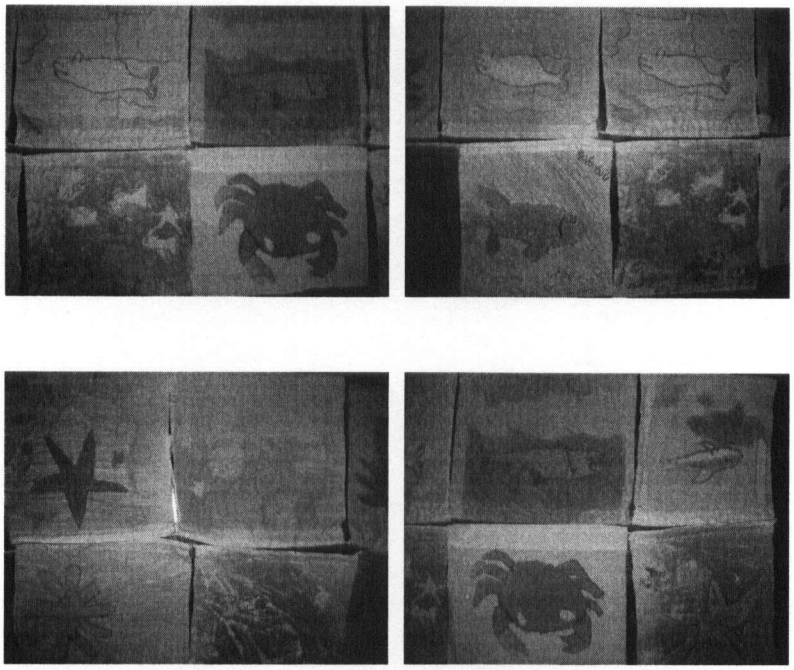


Figure C.10. Observation Animal Banner: Evergreen Elementary

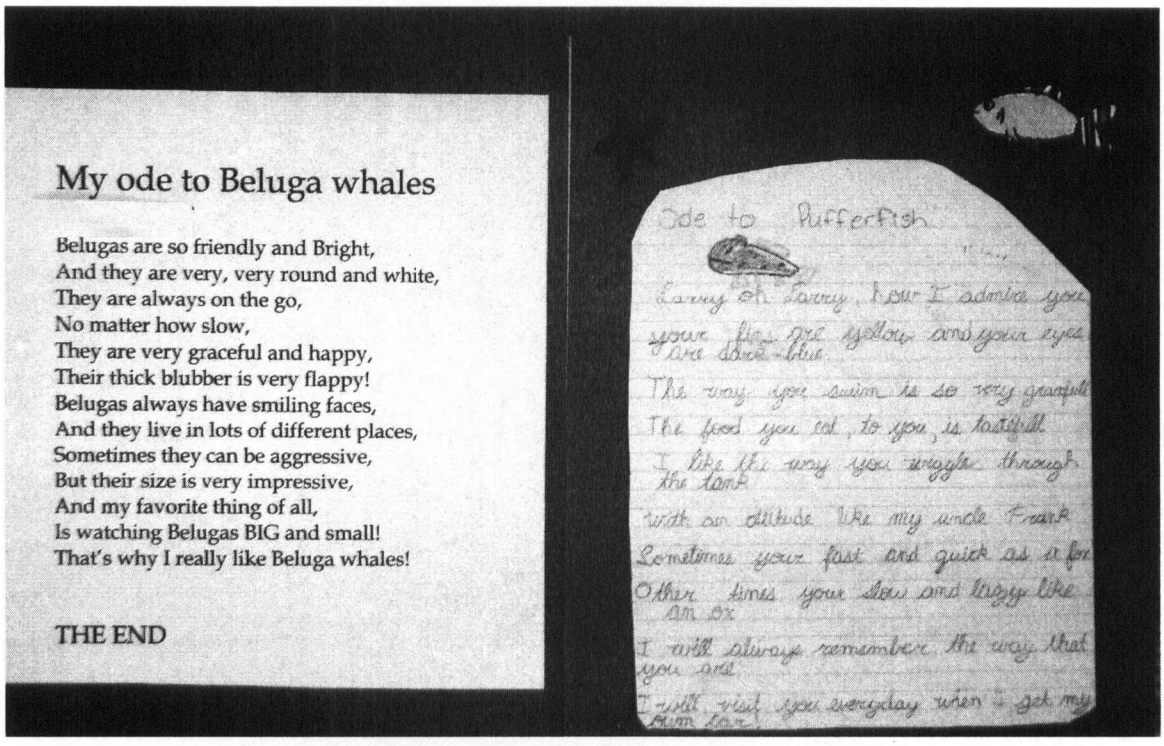


Figure C.11. Observation Animal Odes: Oceanview Elementary