Understanding & Developing Elementary Environmental Education in the Bay Area

A Research Report by
Community Resources for Science

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Thanks to the Walter and Elise Haas Foundation for supporting this project

About Community Resources for Science

Community Resources for Science (CRS) is a nonprofit organization located in Oakland, CA. Our mission is to build a community of educators dedicated to getting kids excited about learning through science. Our programs provide practical support for both teachers and informal educators – helping teachers integrate science into their teaching and helping the many programs in our community be stronger partners for the classroom teacher.

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Acknowledgements

We are proud to serve the many teachers and environmental educators working in our community to educate our children so they may build an informed society making thoughtful decisions about our future. We thank these educators for their daily inspiration and patience, and for helping us understand the teaching needs and educational opportunities for Alameda County elementary students. We thank the **Walter and Elise Haas Foundation** for supporting this study and for their ongoing interest in the impacts of our programs on environmental education. We also thank the Richard and Rhoda Goldman Fund, the Dean Witter Foundation, and the Hut Foundation for their recent support of our work to advance environmental education in Alameda County.

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1. Report Summary

As the importance and popularity of environmental education grows, increasing attention is being paid to the development and sustainability of informal education programs that offer students powerful learning experiences based in the environment. These programs can both enrich and support standard classroom curriculum, offering students experiences with a fascinating array of natural phenomena, practical knowledge, and real-world issues. At the same time, classroom teachers struggle with a variety of issues that challenge their ability to integrate these important experiences into their curriculum.

This report examines the intersection between the array of environmental education programs and the world of the elementary (K-5) public school classroom teacher in Alameda County, CA. Our goal is to understand the context for teachers' choices about environmental programs, in order to reveal opportunities for increasing the availability and impact of environmental education for public elementary school students in the Bay Area. This context includes both the array of available programs, and the motivations and constraints experienced by elementary teachers.

The analysis is framed within two important assumptions:

- ✓ *To be effective, environmental education must reach a broad population of children in our community.*
  Elementary classroom teachers and environmental educators share a powerful goal: to engage young students in exciting learning experiences that help them become lifelong learners, responsible citizens, and capable participants in the community. Public elementary school teachers teach a broad cross-section of the children in our community, including the student population that is least likely to have environmental experiences outside of the school environment. While elementary teachers often feel personally driven by environmental concerns, most find it challenging to build into their classroom plans.

- ✓ *Science is the most powerful curriculum connection for environmental education, and is also the most needed curriculum support area for elementary teachers.*
  While elementary teachers struggle with the content areas of the California Science Standards, environmental education offers teaching opportunities that both resonate with teachers' personal interests, and can create powerful cross-curriculum links through engaging, experiential learning.

Data described in the report support the following broad conclusions:

- ✓ *There is a rich array of well-developed environmental education programs available in the Bay Area.*
  From world-famous science centers and zoos, to spectacular natural phenomena, and cutting-edge research, the Bay Area is overflowing with environmental education opportunities—and the expertise to bring these lessons alive with students. It falls to environmental educators to help teachers understand and integrate these opportunities into their classroom curriculum.

- ✓ *Environmental education programs can help teachers use a wide range of approaches to accomplishing teaching goals.*
  Teachers are increasingly aware of curriculum standards, achievement gap issues, and standardized testing mandates that shape their teaching goals. At the same time, these constraints make it even

more compelling to engage students through powerful teaching that is hands-on, thematic, and based in real-world experiences and issues. Environmental education programs provide great opportunities for elementary teachers to support specific content needs, model curriculum that's integrated across many subjects, and prompt needed skill practice.

- ✓ *Many motivations and constraints influence teachers' enrichment choices*
  Teachers make enrichment selections within a complex framework that includes their personal background and training, the culture and budget of their school, the variety of students in their classroom from year to year, and a kaleidoscope of curriculum adoptions, social programs, and educational trends. Increasing pressure around education funding and standardized achievement goals particularly affect teachers of the neediest students.

- ✓ *Environmental education program providers must attract teachers to their programs in order to forge strong partnerships that accomplish mutual goals.*
  Teachers' priorities and challenges illuminate opportunities for how programs can reach out with valuable support. Knowledge about teachers' needs also provides guidance for refining specific program components so they can become more accessible and valued parts of teachers' classroom plans.

- ✓ *Specific science concepts and types of experiences are relatively underrepresented through local program offerings:*
  - Related to the California State Science Standards, programs offered around the following grade-level concepts could be expanded: **K -** landforms, water, weather observation; **1 -** water, weather observation; **2 -** Fossils, plant behavior, reproduction, sand & soil; (geology, as related topic); **3** - energy, (in particular specific concepts of energy storage, conversion and transportation); **4 -** microorganisms, rocks; (geology, as related topic); **5 -** atmosphere, internal processes of plants, the water cycle, water distribution, weather science.
  - Other topics, such as the human body, gardening, and agriculture, are in wide demand across grade levels and suggest opportunities for expanding existing offerings.
  - Unique community experiences, such as workplace tours and restoration/service learning, could strengthen the variety of offerings and help teachers support kids' excitement about real-world applications of environmental learning.
  - Programs could respond to teachers' transportation challenges, especially in the early grades, by developing programs to use at school sites when appropriate.

- ✓ *Local environmental education providers can become better aware of colleagues to explore opportunities for collaboration and refining their niche and outreach.*
  High numbers of local programs on specific concepts are sometimes justified by the breadth of the topic (habitat, animals, ecosystem) or the local appropriateness (ocean & bay). However, this broad representation in the community can offer opportunities for organizations to develop collegial approaches to refining and marketing their offerings.

We believe that lessons learned here can strengthen environmental education in the Bay Area. In addition, because many of the basic characteristics of teachers and environmental education programs surveyed here may be generalized to other communities, we hope this information can provide a helpful springboard for building support for improved environmental education resources both in Alameda County and beyond.

2. Data Collection and Research Approach

Overview

CRS has gathered data from public school teachers and informal science education program providers in Alameda County over a five-year study period (1997-2002). This data includes information about the teaching profiles and requests for science teaching support from about 800 elementary teachers. It also includes up-to-date descriptions of more than 900 school-day science education programs available to Alameda County elementary students. Of those programs, we have identified more than 700 that support environmental education.

From the raw data, we have developed a series of snapshots that inform our analysis:

1. The range of elementary education programs available to K-5 teachers in Alameda County;
2. The interests and needs of K-5 teachers related to environmental education teaching support;
3. A series of comparisons between teachers' needs and existing programs that reveal opportunities for growth and development.

In addition, we have reviewed recent research on environmental education issues to identify areas where local data resonates with state and national trends. Analysis of all these data forms the basis of our conclusions about how the community of environmental educators can work together to become more effective partners with elementary classroom teachers.

Data Collection

The main purpose of the information in our database is to connect teachers with resources that can help them teach science. In the process of collecting this data, we gather information about each of our client bases that can offer insights into various local science education issues and trends.

Program Data Current through fall 2002, this data describes programs serving elementary students in Alameda County, generally limited to host sites within a one-hour drive from Oakland. (Exceptions are made for a few large, popular destinations such as Monterey Bay Aquarium that teachers will travel to.) "Programs" are defined as specific science learning experiences offered to groups of K-5 students by an established host site. Each offering defined by a host site is described as a separate program using a wide range of characteristics, including:

- type of program (field trip, in-class, assembly)
- type of experience (e.g. nature walk, hands-on activity, live-animal presentation)
- content (specific topics and any connection to CA State Science Standards)
- target grade level(s)
- costs
- location, amenities, availability of public transportation

Many programs cover more than one topic, and most serve a range of grade levels. While CRS records the host site's complete description of each program, as well as specific information about targeted grade level(s), costs, etc., we also use a "keyword" system to streamline our search mechanism. This system allows for up to three keywords to be chosen to identify the main content of each program, meaning one program may cover up to three topic areas. The keywords have been developed to address both the range of topics offered in programs, and the words that teachers use to describe their

needs. The CRS keywords relevant to environmental education and their definitions are shown in **Appendix 1** at the back of this report.

Teacher Data The teacher data for this report was collected by CRS from 799 teachers over a five-year study period (1997-2002). CRS collects two kinds of information from participating teachers. The first is biographical data about their classroom and science experience and issues:

- length of teaching experience
- number of hours of science taught per week
- annual budget for science enrichment
- perceived barriers that challenge each teacher's ability to do science

The other type of information is recorded in the form of requests for science teaching support. During the study period, we received 1,975 requests including the following information:

- specific subject of interest and grade level focus
- type of teaching support (field trip or in-class program, activity, material, website, etc.)
- specific type of experience (overnight, nature walk, assembly, live animal presentation, etc.)

Additional Information Sources In addition to original research data, this report also draws on information gathered from a variety of sources, including the California Department of Education, the North American Association of Environmental Education, the State Environmental Education Roundtable, the California Integrated Waste Management Board, and a previous research study conducted by CRS on field trip transportation in Alameda County.

Research Approach

The main questions driving our analysis of this data are:

- What existing environmental education programs are currently available to K-5 teachers in Alameda County?
- What kinds of programs are teachers currently seeking to teach about the environment?
- How can environmental education providers better serve elementary teachers?

The focus of this analysis is on the intersection between the science content offered by existing environmental education programs in the community and the interests of elementary classroom teachers. The analysis approach starts with a presentation of the spectrum of environmental education programs available to elementary students in Alameda County, both as a whole, and in terms of various large categories that drive teachers' decisions. This is followed by an exploration of teacher "drivers," that is, the factors that affect teachers' decisions to choose one program over another (or none at all). Next, in the context of these drivers, we present data about what types of environmental education programs teachers have requested. Finally, we have correlated teacher requests and needs with available programs in order to facilitate an analysis of gaps, overlaps, and opportunities for collaboration, expansion, or revision of programs.

3. Environmental Education Programs for Elementary Students in Alameda County

There are 906 different school-day science education programs from 147 different host sites currently catalogued in our database. Of the programs offered, we have identified 707 as being generally related to environmental education. This was done by comparing our keywords, founded in the California State Science Standards, with concepts in the National Association of Environmental Education's Guidelines for Learning (K-12). A complete list of the host sites offering these programs is shown in Appendix 2. **Table 1** (following page) shows the broad distribution of programs serving Alameda County K-5 students that support specific environmental education content areas related to science. (N.B. Since most programs address more than one keyword concept, Tables 1 – 8 show a higher overall coverage of keywords than might be expected if each program only addressed one idea.)

Despite the broad range of environmental education topics represented, it is interesting to note in **Table 1** that some environmental concepts are addressed relatively infrequently by the existing programs, while other topics are covered by many programs. For the most part, this spread is justified by the broad relevance of the concept and/or local opportunities for study. The fact that the largest concentrations of programs are around adaptation and diversity, habitat, animals, ocean and bay, and ecosystem is not surprising. The break-out of programs into types—assemblies, field trips, and in-class programs—further illustrates the spread of opportunities available to teachers, with relatively fewer in-class and assembly offerings. The data in **Table 1** shows gaps and overlaps in availability that can offer insights to program developers. The opportunities presented by these gaps and clusters will be analyzed in the context of teachers' requests and needs, and the results summarized in Section 6: Opportunities and Conclusions.

In order to get more information on how existing programs match teachers' interests, we have also looked at the program data from four different perspectives related to the different reasons that teachers seek environmental education programs. The principle guiding this analysis is that teachers take many paths to selecting environmental education programs. Some teachers are guided by interest in a particular subject or theme or experience, some are trying to raise their students' consciousness about a specific issue or behavioral change, and some are driven by meeting specific curriculum standards (particularly the closely related science standards). Tables 2 through 6, presented below, each offer a view of the environmental education programs from one of these teacher perspectives.

Table 1: Overview of Environmental Education Programs by Topic

EE Keywords	# of times keyword is represented	Assemblies	Field Trips	Inclass Programs
adaptation/diversity	157	6	115	36
habitat	112	3	89	20
animals	110	11	71	28
ocean & bay	95	4	76	15
ecosystem	86	8	60	18
web of life	78	10	48	20
natural history	63		52	11
env impact	54	8	32	14
plants	47	1	39	7
resource use & conservation	46	8	27	11
senses	45	2	33	10
animal behavior	44	1	30	13
wetlands	43		38	5
meeting needs	41	5	22	14
marine mammals	40		33	7
endangered & extinct	39	6	25	8
insects & spiders	38	2	29	7
birds	34	1	27	6
geology	31	1	24	6
reptiles & amphibians	27	2	12	13
internal processes-animal	26	2	19	5
energy	25	2	16	7
fish	24	1	20	3
gardening	23	1	13	9
life science	23	1	16	6
life cycle	23		17	6
forests	23	3	16	4
earth processes	22	1	16	5
invertebrates	21		16	5
mammals	20	2	12	6
human body	20	2	13	5
agriculture	19	1	17	1
microorganisms	18		17	1
atmosphere	18	2	11	5
creeks & ponds	17		15	2
water distribution	16		14	2
fossils	14	1	11	2
rocks	14	2	6	6
reproduction	11		10	1
earth science	9		4	5
weather observation	8		6	2
water cycle	8	2	5	1
landforms	8		8	
plant behavior	7		5	2
weather science	7	1	5	1
archeology	6		6	
biology	5		4	1
internal processes-plant	4		2	2
sand & soil	4		4	
water	4	1	3	
Total: 50	**1677**			

Notes

Total # EE programs=707

Most programs represent more than one topic

Each program may cover up to three topics in table

Programs Related to Specific Biomes or Animals

Many environmental education programs focus on particular animals or ecosystems—often those that are either found in the Bay Area or generate special-interest audiences. There are 192 environmental education programs focused on types or groups of specific animals (e.g. insects and spiders, marine mammals, birds, etc.), or nearly 30% of the available environmental education programs. The spread of these programs across different animal groups is shown in **Table 2**. The variety of these programs is notable, as is the fairly even spread across topic areas.

Another focus area for environmental education programs is on particular biomes. Appropriately, almost all these programs focus on local biomes that can be explored with a naturalist. There are 249 programs whose contents address one or several biomes, or almost 35% of the total number of programs. The distribution of these programs across various types of biomes is illustrated in **Table 3**. The most generalized category, "ecosystems," makes up a significant chunk of the program offerings, while "ocean and bay" provides the most program offerings for a specific biome—for obvious reasons given our local ecosystem.

Table 2:
Animal Group EE Programs

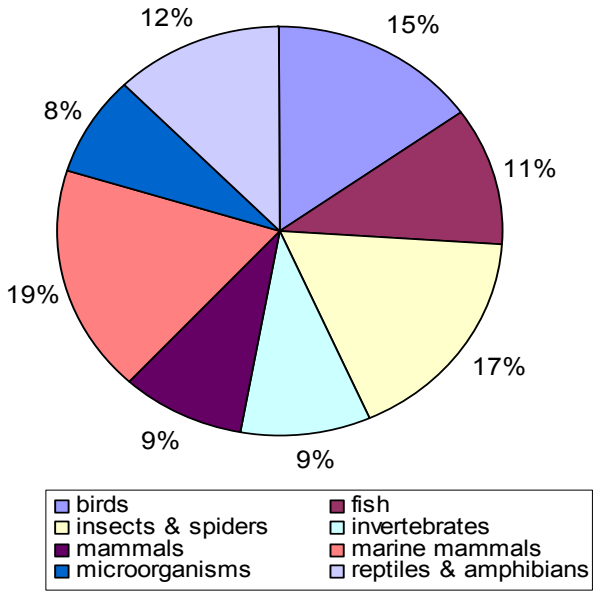
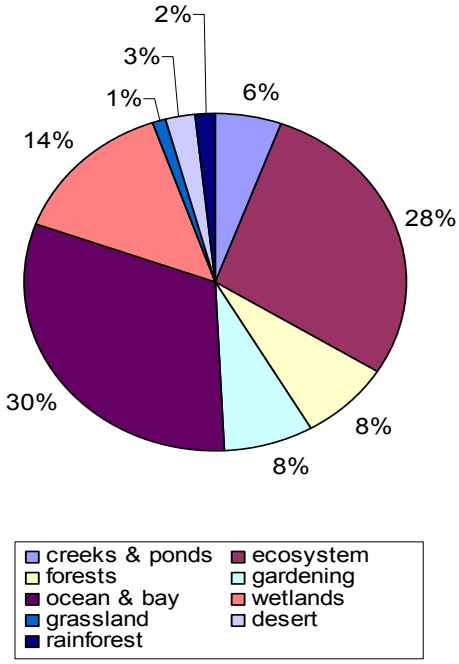


Table 3: Biome EE Programs

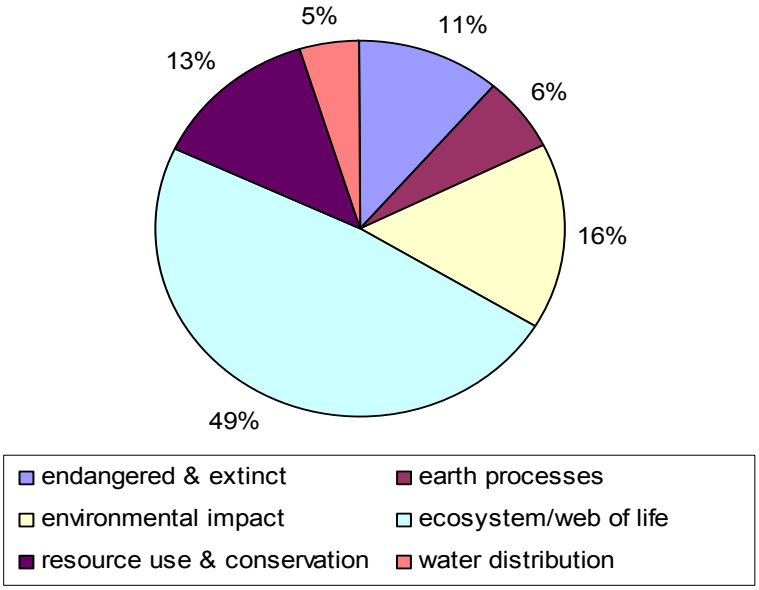


Programs Related to Specific Environmental Issues

Another focus for environmental education programs is on educating the public about particular environmental concepts or issues. Some of the different issues that are related to keywords in the database are:

- The loss of plant and animal species due to extinction ("endangered and extinct")
- Impacts on soil from erosion and agricultural practices ("earth processes")
- Environmental impacts of human activities ("environmental impact")
- The delicate balances of ecosystems and food chains ("ecosystem/web of life")
- Reduce, Reuse, Recycle! The dependence on the earth for resources and impact of waste ("resource use and conservation")
- Conserving and protecting the limited supplies of fresh water that support life ("water distribution")

Table 4: Environmental Issues

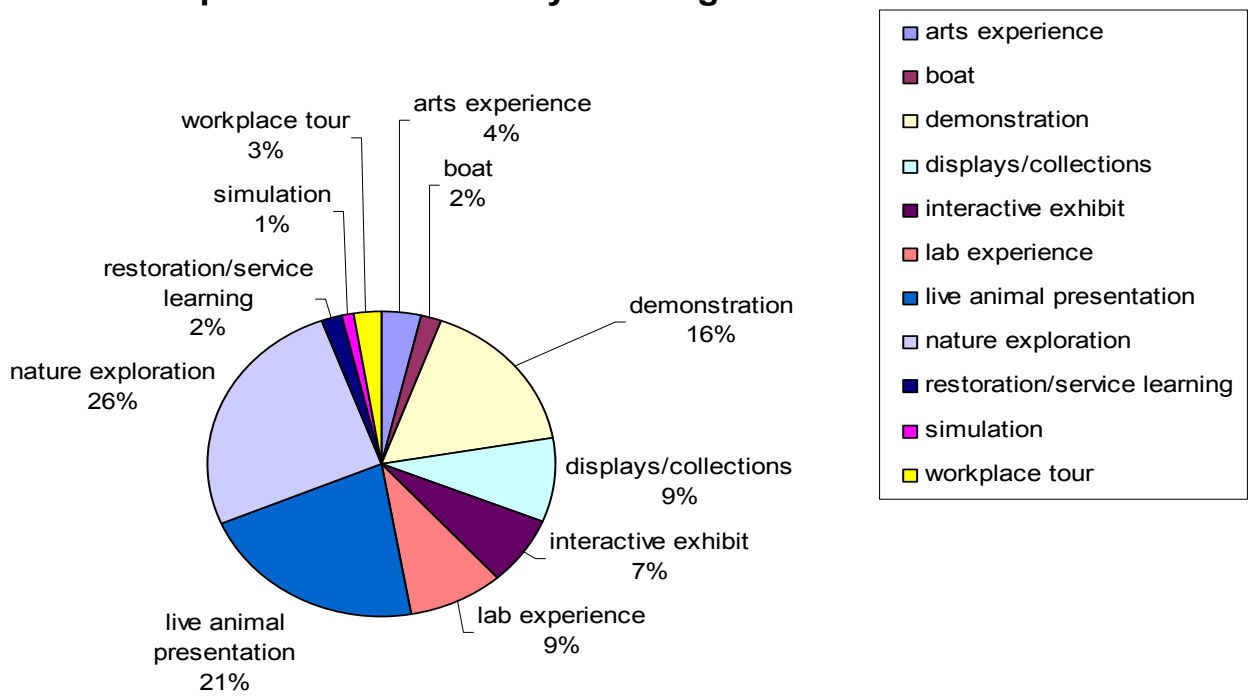


As shown in **Table 4**, of the programs that specifically consider environmental issues as their subject, there is very strong representation among programs around the issues of ecosystem and web of life, and significant support from programs on the subjects of environmental impact and resource use and conservation. Fewer programs are offered locally on water distribution, endangered and extinct species, and earth processes (erosion and soil conservation).

Programs Offering a Special Type of Experience

Programs in the Bay Area offer a wide variety of experiences for the student. Some of these experiences, such as live animal demonstrations, would be difficult for individual teachers to produce, but are key elements in teaching particular ideas. A large part of the student population in Alameda County would not have access to these experiences if they were not provided by informal education programs.

Table 5: Experiences Offered by EE Programs



Local environmental education program offerings are especially rich in nature exploration experiences (26%). The next most frequent offering is live animal presentation, followed by demonstration and/or lab experience. Interactive exhibits and displays and collections are relatively widely available, while more specialized experiences such as boats, workplace tours, and habitat restoration projects are relatively infrequent. It should also be noted that service-learning projects are not always broadly offered as formal programs, since the opportunities vary from year to year, but as targeted partnership programs for specific schools. Consequently, there are probably more individual opportunities for this experience than are captured in our data.

Programs Related to Science Standards

The concepts addressed by the California science standards are grade level specific, so whether a program is related to a particular science standard depends on both how the content area the is described and the grade level(s) targeted. **Table 6** (next page) counts all environmental education programs that address a particular science standard for the appropriate grade level, based on current program descriptions. Again, though it is possible for a program to be counted more than once if it addresses multiple grade-levels and/or topics, the data shows the coverage of standards-based concepts by existing local programs.

The data in **Table 6** reveals some particular standards-related subjects which are currently receiving less coverage than others (boldface selections). The data also shows a breakdown of the type of presentation (field trip, in-class, or assembly) offered, sorted by grade level and standard. This provides another opportunity to examine the range and coverage of standards-based programs.

The extent to which grade-level standards concepts are addressed by available programs reveal some "gaps" that point to opportunities for developing or refining programs to fill teachers' grade-level content needs.

Table 6: Programs Related to State Science Standards

Kindergarten

EE Keyword	Total Programs	Assemblies	Field Trips	Inclass Programs
animals	86	8	53	25
landforms	5		5	
plants	24	1	21	2
resource use & conservation	34	7	20	7
senses	39	2	28	9
water	3	1	2	
weather observation	5		3	2
Totals:	**196**	**19**	**132**	**45**

1st Grade

EE Keyword	Total Programs	Assemblies	Field Trips	Inclass Programs
adaptation/diversity	89	5	64	20
habitat	78	3	59	16
meeting needs	36	5	20	11
water	1		1	
weather observation	7		5	2
Totals:	**211**	**13**	**149**	**49**

2nd Grade

EE Keyword	Total Programs	Assemblies	Field Trips	Inclass Programs
animal behavior	24	1	15	8
fossils	10	1	7	2
life cycle	19		16	3
plant behavior	2		2	
reproduction	10		9	1
resource use & conservation	36	7	21	8
sand & soil	3		3	
Totals:	**104**	**9**	**73**	**22**

3rd Grade

EE Keyword	Total Programs	Assemblies	Field Trips	Inclass Programs
adaptation/diversity	110	5	79	26
endangered & extinct	33	6	21	6
energy	19	2	13	4
env impact	42	8	26	8
Totals:	**204**	**21**	**139**	**44**

4th Grade

EE Keyword	Total Programs	Assemblies	Field Trips	Inclass Programs
earth processes	20	1	15	4
ecosystem	78	8	55	15
microorganisms	16		15	1
rocks	12	2	5	5
web of life	71	10	43	18
Totals:	**197**	**21**	**133**	**43**

5th Grade

EE Keyword	Total Programs	Assemblies	Field Trips	Inclass Programs
atmosphere	15	2	9	4
human body	19	2	13	4
internal processes-animal	24	2	18	4
internal processes-plant	4		2	2
resource use & conservation	42	8	24	10
water cycle	8	2	5	1
water distribution	14		13	1
weather science	5	1	4	
Totals:	**131**	**17**	**88**	**26**

4. Elementary Teachers in Alameda County

The goal of school day environmental education programs is to engage students in active learning in and about their environment. However, without understanding and buy-in from classroom teachers, this target audience will not be reached. This is particularly true in reaching the large local population of underserved kids: kids from mainly urban surroundings, kids whose families may not have access to a range of outdoor experiences, kids whose teachers work within administrative structures that are deeply determined by standardized tests and mandated curriculum reforms.

Although environmental education can be attractive to teachers in many ways, most elementary teachers in Alameda County do not make an established practice of incorporating environmental education into their teaching plans. Elementary classroom teachers have a wide variety of needs and situations. They are the decision-makers in crafting lessons and learning approaches that will meet the needs of each particular class. They must weave together adopted curriculum material, best teaching practices, and diverse learning experiences to help their students acquire developmentally appropriate and required skills and knowledge. Getting a picture of these situations and needs is an important step for understanding how environmental education programs can provide more effective support and become a fully integrated element of a teacher's plan for classroom instruction.

To provide insight into teachers' needs and challenges, we will start with demographic data about teachers and the students they serve, and move into a more qualitative look at teachers' barriers and motivators.

Basic Data

Demographic Data for Teachers and Students In Alameda County there are more than 5,500 (5568) teachers from 211 elementary (K-5) public schools, teaching nearly 150,000 students. The student population in Alameda County public schools is 30% White, 19% African American, 25% Latino, and 18% Asian. Nearly 1/3 of Alameda County teachers and schools (1,600 teachers from 66 schools) are from Oakland Unified School District, where 44% of the student body is African American, 30% Latino, and 16% is Asian. Overall, 30% of Alameda County's student population qualifies for free or reduced lunch; in Oakland the proportion is 49%.

Class Size Typically, teachers of grades K – 3 have 20 students in their classes, while teachers in grades 4 and 5 are in charge of around 30 kids. (It should be noted that anticipated cuts in educational funding may drive these numbers up in 2003.)

Teaching Experience The study group for this analysis spans a wide range teaching experience, as shown in **Appendix 3**. The data indicates that almost 25% of the teachers in our study group have between one and five years' teaching experience; more than half have less than 10 years experience.

Classroom Context

Curriculum Generalists Most elementary teachers have a group of students all day for all subjects, and cover a wide range of curriculum using a constantly changing array of techniques and materials. Credentialing requirements for elementary teachers currently do not include specific, single-

subject training, and much focus is placed on developmental instruction and teaching the basics of reading, writing, and computation**.**

While this "generalist" approach would seem to encourage an integrated approach to teaching the required subjects, curriculum is formally adopted and renewed in cycles, in discrete and separate subject areas. In general, the assumption delivered through adopted curriculum materials, including kits, textbooks and workbooks, is that each subject area requires extensive, focused instructional time. Other mandated programs like drug use prevention and conflict management curriculum are usually structured as separate drop-in (or pull-out) programs. In addition, teachers in many under-performing schools in Alameda County are required to teach particular curriculum on strict schedules. Although these structures add further challenges to integrated teaching approaches, elementary teachers know that lessons with integrated curriculum tend to engage the student, and they try to combine subject areas where possible.

Pedagogy Challenges In their focus on teaching "the whole child," elementary teachers everywhere are expected to be working to engage students with varied learning styles, create active learners, and build strong citizens. In our diverse, urban community teachers also help significant numbers of children learn English and facilitate building a heterogeneous community of languages and cultures, further broadening the range of both social and scholastic challenges. Often the teachers with the most diverse classrooms also face the most limited budgets and classroom support structures.

Time Challenges Teachers have limited time for classroom planning and preparation to meet this broad teaching mandate, and even less for the professional development to learn new content and pedagogy. This time pressure in the classroom contributes to the motivation to integrate multiple curriculum goals into lessons, despite the challenges to integration described above. The limited planning time available makes teachers particularly interested in programs or materials that help them address content or practice skills from several curriculum areas, while providing deep support in targeted subjects.

In addition to time pressures around teaching and planning, teachers also face an amazing amount of administrative work related to various school, district and union requirements, covering everything from grading to ordering classroom repairs and buses. In addition, they process a tidal wave of information, only a fraction of which is brochures and flyers from individual enrichment opportunities. This makes getting teachers' attention for particular opportunities difficult.

Science Teaching Issues The general focus of elementary teachers on literacy and numeracy is compounded by the current testing-oriented environment which assesses primarily math and reading skills. This emphasis, combined with a general lack of experience and confidence in science, and the time pressures in the classroom, leads many teachers to leave science behind in both their training and their teaching. A 1990s survey by the National Science Teachers Association found that 82% of elementary teachers feel qualified to teach reading, but only 27% feel qualified to teach either physical or earth/space science**.**

Publication of the California Science Standards, followed by textbook adoptions, and the anticipated addition of science to the STAR testing in 2003, are all factors contributing to a shift in the way teachers and administrators prioritize science teaching. The California Science Standards lay out the foundation for basic science literacy, introducing and developing ideas as students grow. (See **Appendix 4**: Summary of California State Science Standards.) Textbook and curriculum adoptions happen in cycles, and science adoptions following the publication of the Standards in 2000 are required to reflect their specified grade-level content. In 2003, science will be added to STAR tests for 5th, 8th,

and 11th grade students for the first time, indicating teachers and administrators will become increasingly anxious about understanding and implementing powerful science curriculum.

Data on Teachers' Needs

A recent statewide teacher needs assessment survey published by the Integrated Waste Management Board reports that respondents say their teaching of environmental education concepts is "contingent upon preparation time required, hands-on emphasis, alignment to standards, and cost." These barriers align generally with responses from CRS's study group of elementary teachers. When elementary teachers are asked specifically about what they need in order to integrate more science into their classrooms, the top four needs listed are classroom materials, more prep time, more class time and more money, in that order. (See **Appendix 3**) Of these top four needs, three are particularly interesting for this analysis:

Materials The expressed need for more materials reflects teachers' anxieties about locating, purchasing, and managing the kits and supplies, as well as background information they need, to do hands-on experiments and lessons addressing integrated curriculum. Some teachers tend to believe that complex materials are required "to do anything interesting," or feel unable or too busy to locate or develop materials on their own. The need for specific materials related to their plans are felt also in their concerns about time and money.

Class time The need for more class time is an overall reflection of a schedule crowded with pull-out programs and standardized testing, but is also unique to science because of the time required to set up, manage, and clean up hands-on activities. Teachers in districts with mandated curriculum schedules (such as Oakland's Open Court program) experience even tougher time constraints due to the time requirements of these programs. Teachers appreciate every insight into how they can create integrated teaching programs—units and lesson plans incorporating content exploration and skill practice in several disciplines.

Money Many teachers say they would teach more science if they had more money. In general, teachers in Alameda County tend to plan one or two field trips per year, and have a small classroom budget (under $200) for "extras." While budget constraints certainly apply to the purchase of classroom supplies and curriculum materials, teachers most often cite the cost of transportation as the barrier to taking more field trips.

Field Trip Barriers

Teachers want to take their students on more field trips, but even when the program admission is free they are constrained by the difficulties and costs of field trip transportation. Transportation costs are the largest expense for most field trips. While costs vary from district to district, a CRS survey conducted in 2000 showed the average cost of a field trip in a district that provides its own buses was $287; for a district requiring charters the average was $425. While involving parents in arranging carpools or collecting fees are options in many districts, parent participation is often least reliable in the schools most in need. Teachers in grades K and 1 have added logistical issues around field trips, both because their students are less mature and because new car seat requirements limit field trip transportation options.

Teacher Motivators for Integrating Environmental Education

We have already pointed to some of the external motivators teachers feel for integrating environmental education into their classroom curriculum: student achievement; the new California State Science Standards; and the prospect of standardized testing in science. Also important are internal motivators that make incorporating environmental education a natural choice. All teachers draw on their own interests, strengths, and community values to help fuel their teaching. These personal interests, combined with responding to the challenges described above, create some key motivating goals. Environmental education programs can help teachers:

- Teach specific content and skill development;
- Engage their students in active learning across many curriculum areas;
- Encourage students' social development and community involvement.

Specific Content & Skill Development Elementary teachers are most interested in resources that will help them meet their already towering curriculum requirements. The Integrated Waste Management Board's recent Educator Needs Assessment survey states "educators expressed relatively high levels of interest in teaching environmental concepts, particularly when those concepts are relevant and standards-based;" and that "science was the discipline most frequently identified" by educators interested in focusing on one discipline. In general, teachers' requests to CRS for science support tend to follow the grade level science standards. This driver will become even more powerful as the state begins to measure student performance in science.

The State Science Standards contain specific science content and process skills that are closely aligned with environmental education goals. The publication of The National American Association for Environmental Education (NAAEE) titled Excellence in Environmental Education: Guidelines for Learning (K-12) describes four strands for the environmental curriculum: "Questioning and Analysis," "Knowledge of Environmental Processes and Systems," "Skills for Understanding and Addressing Environmental Issues," and "Personal and Civic Responsibility." The first two strands outline process skills and content knowledge that are closely aligned with both the National Science Standards and the California State Science Standards. We focus here on these science correlations.

The State Science Standards articulate basic concepts and particular skills, leaving the choice of approach or experience open to the teacher. The exciting variety of lesson plans for reaching the required concepts can generate from teachers' individual interests, or their unique teaching challenges (such as multi-grade classrooms, ELL/ELD or bilingual programs, "magnet" curriculum, etc.), or the engaging array of resources available.

Table 7 (next page) shows the complete record of teacher requests received for environmental education programs during the study period, organized to relate the number of requests by both key word and grade level. The bands of color show the keywords assigned to the indicated grade level by the science standards, darker for the specific grade and lighter for mixed grades or related concepts within the grade. This data reveals some interesting trends:

1. Approximately 1/3 to 1/2 of all requests received for environmental education topics are related to grade-level science standards.
2. Mixed grades tend to be even more focused the standards, probably due to the pressure to cover more curriculum areas.
3. Other selections demonstrate continuing cross-grade interest in specific topics (insects/spiders) or thematic approaches (ocean & bay) that will engage young students.

Table 7: Teacher Requests by Grade

EE Keyword	Total	0-5	0	0-1	1	1-2	2	2-3	3	3-4	4	4-5	5
agriculture	36	2	13		8	3	5	1			1		3
archeology	2	1			1								
biology	2										1		1
birds	11	2			1		2	1		2	2		1
creeks & ponds	18	1	1		1	1	8	1	2		2		1
earth science	7	1	2						2		1		1
fish	11				1		5	2	1				2
forests	10			2	1	1	1		3				2
gardening	64	5	13	2	8	2	13	1	13		4	1	2
geology	64	1			3	2	9	5	12		25	4	3
insects & spiders	52		12		19	6	13	1	1				
invertebrates	1								1				
life science	10	1	2		3			1			1	1	1
mammals	11		2		4	1	1		2	1			
marine mammals	35	2	1		6	2	7	1	3		7		6
natural history	38			1	1		1		22		6	5	2
ocean & bay	77	5	7	1	16	1	8	1	16		9	2	11
reptiles & amphibians	11	1	2		1	2	3	1	1				
wetlands	19	2	1	1			5		6		1	1	2
animals	48	2	17	2	7	4	6	3	3		1	1	2
landforms	17	2	4	2	1		2	2	1		2		1
plants	34		9	2	5	2	7	2	4		1	1	1
water	21	2	1		2	4	1		2		4	4	1
weather observation	39	1	5		13	4	7	2	5				2
resource use & conservation	46	2	6		3	3	12	2	11			4	3
senses	13	1	7	1	2		2						
habitat	42	2	3		5	3	14		12	1			2
meeting needs	18		4	1	7	4	1		1				
adaptation/diversity	22				2	2	1	1	14				2
animal behavior	14		1		4	1	3	2	1		1		1
life cycle	50		6	2	4	4	22	5	5		2		
plant behavior	8				1	1	2	2	1				1
sand & soil	19				2	2	9	3	3				
fossils	16					4	8	2	1		1		
reproduction	11					3	6	1	1				
env impact	20		1		3		2		4		4		6
energy	26	1			4		1	2	12			6	
endangered & extinct	19		2		2		2	1	9		1		2
microorganisms	1											1	
rocks	29	1			1	1	4	1	6		13	2	
ecosystem	34		1		2		5		9		12	3	2
web of life	22						1	2	3		14	1	1
earth processes	24	2			1	1		1	2		13	2	2
atmosphere	2											1	1
water cycle	11	1							2		2	3	3
water distribution	12	1	1			1	1	1			3	3	1
weather science	12	1			1		1				1	2	6
human body	38	2	2		7	3	6		9		2	1	6
internal processes-animal	13		1						3		1	3	5
internal processes-plant	3											1	2

Note: Some spread of requests outside the appropriate standard keywords is attributed to teacher grade level reassignment. Darker highlighted squares are keywords assigned to standards at that grade. Paler squares are keywords related to grade-level concepts or mixed grades.

Engaging Students in Active Learning A motivator for some teachers is the power of environmental education to engage students in active learning. Recent research on effective environmental education echoes decades of research on best practices in education, and science teaching in particular. In the report "The Effects of Environment-based Education on Student Achievement," Lieberman and Hoody substantiate results of their approach, Environment as an Integrating Context for Learning (EIC). "Evidence gathered from the study of over 60 schools indicates that students learn more effectively within an environment-based context than within a traditional educational framework," the report states. They define the EIC approach as "interdisciplinary, collaborative, student-centered, hands-on, and engaged."

These descriptors closely follow the research-based approach developed by Roger Bybee for the BSCS curriculum: "The 5 E's: Engage, Explore, Explain, Extend, and Evaluate." Fundamentally, environmental education allows teachers to implement this best-practice model by:

- catching a child's curiosity with a question or new experience.
- providing direct and hands-on experiences;
- offering a wide range of experiences for children with different learning styles;
- connecting concepts and activities with the students' world of knowledge (about local places, people, issues)
- presenting opportunities for discussion, writing, mapping, graphic, reporting, debating, and illustrating a common experience.

Because science is so engaging for students, even reluctant science teachers may eagerly incorporate environmental content that can fuel teaching in other curriculum areas. Many teachers build units around particular animals popular with kids, or local biomes, to get their kids interested in larger content ideas or to focus general skill practice, like writing reports or collecting and graphing data.

Connecting Students with Real-World Issues and Community A powerful teacher motivator with is how environmental education provides opportunities to connect science and social issues. An important part of the elementary curriculum is helping students understand their place in a neighborhood and larger community. Teachers serving economically-challenged communities in Alameda County are committed to the idea of enlarging their students' awareness of the broader community and their own opportunities. Enrichments that expose these students to the wider community and natural world are particularly compelling.

In addition, many teachers are committed to fostering citizenship and responsibility. Environmental education helps teachers show students that the skills of observation, data-collection, analysis, and interpreting and communicating their findings can empower students to make good decisions in their lives and even effect positive change in their communities. This link between science, the environment, and social action is an important opportunity, yet interestingly, the Waste Management Board's survey shows that, statewide, "educators are generally unaware of any environmental projects and service-learning opportunities currently taking place in their districts."

5. Comparing Program Availability with Teachers' Interests

The preceding sections addressed the local context for environmental education school-day programs both in terms of the big picture of available programs, and in terms of how teachers might choose and use specific programs. This section describes how that array of program choices lines up against the actual choices teachers are making. The analysis looks at programs from each of the major teacher motivators: support for science standards, powerful, popular themes or topics that engage students outside of the standards, particular experiences that broaden understanding or connect the students to their community.

Support for Science Standards The level of interest shown in the requests and growing pressure to cover the grade level science standards creates opportunities to attract teachers by addressing these grade-specific topics. As shown in **Table 6**, there are some programs offered for each of the environmental education keywords related to the standards for each grade level. However, some keywords are not addressed as frequently as others, showing less emphasis within the descriptions of currently available programs. In general, there are fewer in-class and assembly programs offered than field trip opportunities. The specific subject "gaps" at each grade level are listed below:

K & 1st **Water** *(physical properties of water)* and **weather observation**, keywords for both grades, and **landforms,** a keyword for Kindergarten, are less represented by current program descriptions.

2nd **Fossils, plant behavior (***response to changes in light, water, gravity***), reproduction,** and **sand & soil** are less represented areas for 2nd grade. **Geology**, often requested by this grade level in connection with **sand & soil** units, is also underrepresented by current program descriptions. There are fewer programs in general matching the age and content keywords for 2nd grade**.**

3rd 3rd grade standard topics are fairly well represented. The **energy** standard at 3rd grade is least represented.

4th The underrepresented topics in 4th grade are: the role of **microorganisms** in ecosystems, and **rocks**.

5th Several topics are currently underrepresented for 5th grade, including **atmosphere**, **internal processes of plants, the water cycle, water distribution, and weather science**. Weather science is a particular need, because it is a difficult subject for most 5th grade teachers to address. 5th grade also shows fewer programs in general targeted at the age group and specific topics in the science standard.

In addition to these topics, the particular transportation challenges facing Kindergarten teachers make the relatively underrepresented **in-class programs** attractive for <u>any</u> of the Kindergarten subjects. Kindergarten teachers still ask for field trip information, but are less likely to travel than older grade levels. Assemblies may also be attractive, but may be difficult to make both age appropriate and content specific for this age-group.

Support for Engaging Topics and Themes Review of the pattern of teacher requests during the study period (**Table 7)** reveals several themes and topics that draw strong teacher interest across grade several grade levels, whether or not they are based in the standards concepts. This broad distribution illustrates teachers' strong interest in subjects that can be used as vehicles to engage their students in learning across the curriculum, and the general popularity of environmental themes. The particular themes and topics that emerge from the subject request data, arranged in order of relative level of teacher interest are:

Order	Engaging Topic	Spread of Requests
1.	gardening, agriculture	especially K-3
2.	ocean & bay	across grades
3.	insects/spiders	especially K-3
4.	human body	across grades
5.	wetlands, creeks & ponds	across grades
6.	marine mammals	across grades
7.	environmental impacts	across grades

While all these topics offer opportunities for attracting elementary teachers, a review of the demand for these topics in the context of the number of programs available in the community (**Table 1**) suggests that even more emphasis could be placed on a few of these subjects to respond to teachers' interests. In particular, the number of requests across grade levels for "human body," and for "gardening," and "agriculture" in the early grades, compared to the number of programs available to support this interest, indicates that there may be real opportunities to further develop these topics.

Support for Unique Community Experiences There are many experiences in our community that can help teachers connect students to larger social issues, or enrich their view of the community and themselves. However, when compared to teachers' interests in particular experiences, the range of experiences shown in **Table 5** reveals some interesting gaps. As discussed in Section 4, teachers are interested in enrichments that offer experiences that can't be duplicated by the teacher, and enrich students learning or view of their role in the community. Good examples of these kinds of experiences include: studying unique outdoor ecosystems, hands-on labs, planetariums, live animal experiences, workplace or role model experiences, and restoration/service learning experiences. The latter two experiences, workplace tours and restoration/service-learning, make up about 3% and 1% of the program offerings respectively. Additional opportunities for these kinds of experiences offered as part of a program experience would provide more opportunities to integrate environmental education into the elementary curriculum.

6. Opportunities and Recommendations

Looking back at the data presented, several interesting pictures have emerged. This section summarizes the opportunities and guidelines that can help environmental education providers attract elementary teachers to their programs in order to forge stronger partnerships with elementary classroom teachers.

Refining and Growing Environmental Education Programs

The analysis of teachers' interests and available programs has revealed many opportunities for environmental education programs to reach more elementary students in Alameda County and strengthen the larger educational community. Knowing more about the local context of school-day environmental education programs, providers can refocus their offerings, designing new programs and exploring collaborations where appropriate.

The science standards, specific interest areas, and particular "gaps" all reveal opportunities to connect with the elementary teachers. Existing programs can clearly articulate their content related to teachers' needs. They can also strengthen their support to teachers by refocusing program topics or developing new offerings. The particular opportunities for growth identified in the preceding sections are:

- Identify and build connections to specific grade level concepts and skills in the California science standards (see **Appendix 4**).The following grade-level areas are particularly underrepresented in current program descriptions:
  K: landforms, water, weather observation
  1: water, weather observation
  2: Fossils, plant behavior, reproduction, sand & soil; (geology, as related topic)
  3: energy, (in particular specific concepts of energy storage, conversion and transportation.)
  4: microorganisms, rocks; (geology, as related topic)
  5: atmosphere, internal processes of plants, the water cycle, water distribution, weather science

- Identify and build new program offerings supporting second grade and fifth grade science standards, both of which are reflected in significantly fewer program offerings than other grade levels.

- Build in-class offerings across all grade levels, with particular attention to Kindergarten and first grade, for those program experiences that can be effectively transported to the school site. Widespread difficulty in arranging the time, logistics and costs of whole-class field trips suggest an opportunity for creative development of programs that could work either in the classroom or schoolyard.

- Identify and build program connections to engaging themes and topics, with particular attention to human body, and gardening, and agriculture.

- Identify and promote experiences that enrich, inspire and involve students, with particular emphasis on service-learning/restoration and workplace/role model experiences.

Another opportunity for strengthening the environmental education community is revealed by the concentration of many programs related to a few subjects, as shown at the top of **Table 1**. Programs with related environmental concepts can explore a variety of different levels of communication and collaboration in order to engage the broadest possible student population in the subject. One possible mode of collaboration might be to coordinate offerings that explore different facets of a related topic. For example, among the more than 150 programs offered around the topics of ocean and bay, creeks and ponds, and wetlands, a watershed "curriculum" might be developed that helps teachers understand a progression of standards-related concepts to explore through a variety of environmental experiences. Other collaborative approaches might include: developing shared publicity vehicles

around various themes, or developing cooperative professional development opportunities—either for classroom teachers about the science content around the concept, or for the environmental educators about how to respond more effectively to teachers' needs. At a minimum, increased dialogue among educators working in popular subject areas would help programs identify their niche and communicate target group more effectively.

Guidelines for Building Strong Relationships with Elementary Teachers

While knowing about the local context of programs can help environmental educators be more aware of the topics teachers need support with, as well as the distribution of available programs on the range of topics, knowing more about teacher drivers can also help environmental educators attract teachers to their programs. The following principles are gathered from the data analyzed above, and can be used by program providers to help refine existing programs or in the development of new ones:

- Let teachers know how programs support their needs related to: required curriculum at targeted grade levels, engaging topics or themes with curriculum connections, and/or experiences that enrich, inspire, or involve students.
- Help teachers understand connections between the experiences offered and grade-level curriculum standards during the experience itself.
- Pay attention to developmentally-appropriate concepts as well as experiences.
- Develop useful pre- and post-experience materials (classroom activities, background information, web links, etc.) that support both teachers' and students' deeper exploration of the concepts involved.
- Include cross-curriculum links (literature, math, history, art, P.E.) to support teachers building integrated units around the experience.
- Suggest service-learning projects that link classroom curriculum with environmental action.
- Understand financial limitations for school groups, both around transportation and material suggestions; and help teachers find appropriate solutions (public transportation, recycled/reused and natural materials).
- Use marketing strategies that focus on student outcomes: achievement goals as well as social outcomes.

7. Next Steps

While we are pleased to be able to offer concrete information about the relationship between teacher needs and locally-available programs, and anticipate constructive responses, this survey has raised additional issues and questions that could further inform progress.

Issues

- Environmental educators may need additional support or training around standards-based classroom curriculum in order to become the strongest possible partners for classroom teachers.
- Environmental educators may need support for developing program descriptions and promotional materials that describe their offerings so that teachers understand how they help meet classroom curriculum and achievement goals.

- Many classroom teachers need ongoing assistance with understanding the science content connections as well as planning and logistical support in order to take advantage of the wealth of environmental education opportunities available in our community.

Future Research

- A study of the impact of environmental education field trip and in-class programs on student learning (particularly in science) would be valuable information for the education community.
- A deeper understanding of the long-term impact of environmental education professional development on classroom teaching and learning could support the refinement and delivery of effective training.
- The Bay Area provides a particularly rich context for environmental education. Understanding and coordinating resources in Alameda County could provide a model for other local communities, as well as efforts in other parts of the state or the country.

We hope this report adds to the ongoing community effort to develop our rich environmental resources so that our children can reap the enormous benefits of active environmental education.

8. Appendices

Appendix 1: List of CRS EE Keywords

Appendix 2: List of Host Sites offering EE Programs to Alameda County Students

Appendix 3: Summary of Teacher Data

Appendix 4: Summary of CA State Science Standards

Appendix 1: List of CRS EE Keywords

CRS EE Keyword	Definition
adaptation/diversity	unique structures or behavior, diversity in different environments, includes evolution
aerodynamics	
agriculture	
animal behavior	includes animals meeting needs & responding to environment (env factors/stimuli)
animals	overview major groups, appearance & behavior, identify external structures,stories, specific groups not listed separately
archeology	study of past life and conditions on earth, methods, individual scientists
astronomy	observing moon, sun, stars (daily, seasonally), study of space, telescope, constellations & uses of stars, planetariums
atmosphere	air pressure, air
atoms	components of all matter, a few atoms/elements make all living things, electron microscopes, periodic table, form orderly molecules
biology	study of life, methods, individual scientists
birds	external features of birds, how meet needs, unique reproduction, includes owl pellets
chemistry	properties of common molecules, separating mixtures, identifying compounds, solutions, reactions, combustion
creeks & ponds	includes local examples, freshwater aquatic life
earth processes	includes erosion (weathering, transport, deposition),earthquakes, volcanoes, landslides
earth science	general earth science topics, ranging
ecosystem	ecosytem types (tidepools, forests, desert, rainforest, grassland,etc.), organic/inorganic parts, concept of relationship, native wildlife & plants
electricity	circuits, electric current, electromagnets, behavior charged objects (repel/attract), use of electricity for heat, light, motion
endangered & extinct	includes concept, dinosaurs, endangered species
energy	energy storage, conversion to different forms, movement (as waves (light, sound), electric current, moving objects), includes solar energy
env impact	LT change env, includes human impacts (pollution, noise, consumption), species overpopulation
fish	external features of fish, how meet needs, unique reproduction
force/motion	types of force, gravity effects on earth, magnetism as a force, mechanical force, includes whirlpools, vortices (see magnetism also)
forests	
fossils	plant and animal fossils
gardening	school gardens, plant growth, organic gardening, farming, terrariums
geology	general, study of earth's soils & rocks, history, formation, individual scientists, methods
habitat	environment where LT can meet needs, different habitats
human body	external features, 5 senses, brain, anatomy, health, nutrition
insects & spiders	external features of insects & spiders, how meet needs, unique reproduction, includes butterflies
internal processes- animal	internal structures, systems, and basic physiology, digestion, respiration
internal processes- plant	internal structures, systems, and basic physiology, photosynthesis, respiration
inventions	specific inventors, inventions, history
invertebrates	unique features of invertebrates, how meet needs, includes worms
landforms	includes bay, mountains, valleys, rivers, creeks, oceans, beaches as landforms
life cycle	comparisons, and individual life cycle examples
life science	general life science topics
light	energy comes to earth from sun as light, shadows, reflection, color, vision
magnetism	magnetic poles (repel/attract), magnets can apply force to some objects
mammals	external features of mammals, how meet needs, unique reproduction, (see also marine mammals)
marine mammals	
matter	materials, describing properties (color, feel, buoyancy, flexibility, weight, etc.); states (solid, liquid, gas); changing properties w/ mixing, heating
meeting needs	how features LT meet needs(for energy(food/light), water, shelter) in diff env, includes teeth, roots, leaf shape
microorganisms	types, beneficial role in ecosystems, human body, germs
natural history	historic habitats, change over time

CRS EE Keyword	Definitions (cont.)
ocean & bay	marine science, marine life, Pacific Ocean, includes tidepools and sandy beaches, local examples
physical science	general physical science topics
physics	study of physical science, individual scientists, methods
planets	definition, planets orbiting Sun, characteristics, Moon and other planetary moons
plant behavior	plants responding to environmental stress, germination & growth (due to change light, gravity, stress)
plants	overview major groups (includes trees, cacti, grasses, fungi), appearance & behavior, identifyexternal structures,stories
reproduction	genetics, inherited traits, variance in population, different methods, role of seeds, flowers, fruit, eggs, live-born mamals, pouch reproduction,
reptiles & amphibians	external features of reptiles & amphibians, how meet needs, unique reproduction, includes frogs, snakes, etc.
resource use & conservation	meeting needs w/ Earth's resources (food, shelter, water, fuel) consumption, reuse, recycling
rocks	formation & types (igneous, sedimentary, metamorphic), rock cycle, properties, rock-forming minerals, break down (freezing/thawing, root growth)
sand & soil	types, composition, characteristics (texture, water retention, fertility)
science careers	
scientific processes	inquiry, hypothesis, ideas, inventions, models, design, variables, measurements, methods, dissection
senses	experiencing with our senses, differences among animals, including humans, includes sensory impairment
simple machines	building, concept of work, simple machines and motion, levers and pulleys
solar system	Sun, other components of our system, characteristics, planetary & star gravitational attraction
sound	sound is vibration, pitch, volume, hearing, sound waves carry energy
space exploration	rockets, satellites, space suits, astronauts
structures/design	building and design, shapes, architecture, forces, load
technology	internet, computers, robots, lasers
water	includes properties, evaporation
water cycle	includes elements of cycle, water vapor, freezing point, clouds, fog
water distribution	includes fresh and salt distribution on earth, local water sources and watersheds, concept
weather observation	types of weather, tools to measure, seasons, climate
weather science	wind, convection currents, interaction of ocean & water cycle, causes of severe weather (hurricanes, tornadoes, typhoons) maps& forecasts
web of life	roles in ecosystem & food chains (producer, predator, prey, decomposer), interconnected relationships between plants & animals, marginal species
wetlands	includes marshes and estuaries, local ecosystem examples

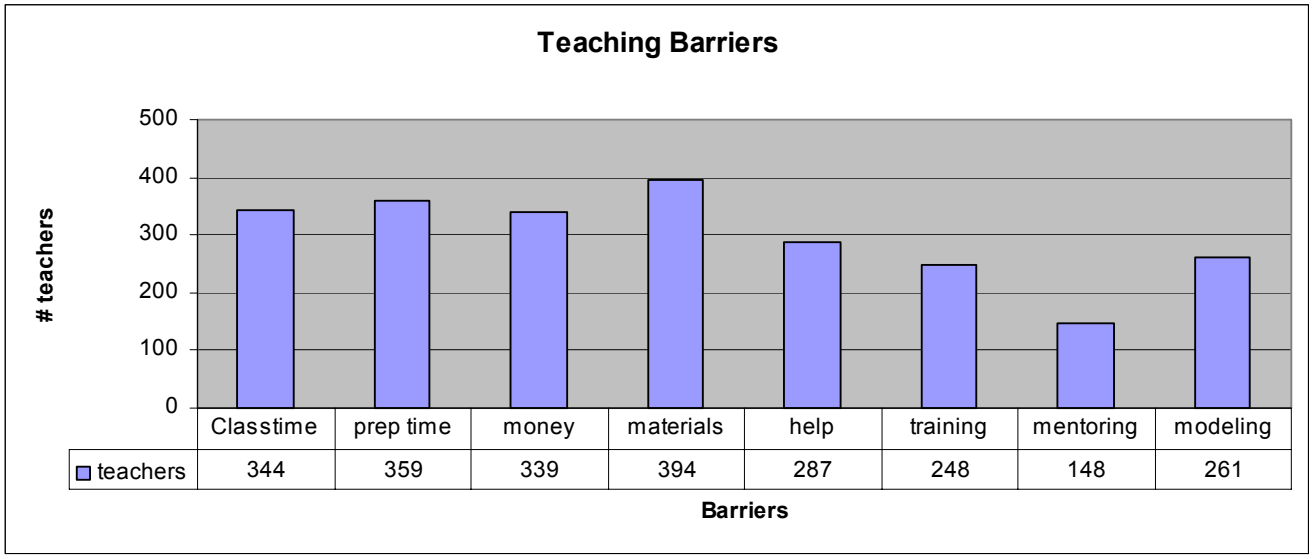
Appendix 2: List of Host Sites Offering School Day EE Programs to Alameda County K-5 Students

Host Site	City
Alameda County Resource Conservation District	Livermore
Alameda County Waste Management Authority	San Leandro
American Lung Association-Alameda	Oakland
American Red Cross	Oakland
American River Water Education Center	Folsom
Andrew Aguilar	Santa Rosa
Angel Island Association	Tiburon
Ano Nuevo State Reserve	Pescadero
Aquarium of the Bay	San Francisco
Audubon Canyon Ranch	Stinson Beach
Banana Slug String Band	Santa Cruz
BART	Oakland
Bay Area Discovery Museum	Sausalito
Bay Model Visitor Center	Sausalito
Blackhawk Automotive Museum	Danville
Bodega Marine Lab	Bodega Bay
Brannan Island State Recreation Area	Rio Vista
Cache Creek Conservancy	Woodland
California Academy of Sciences	San Francisco
California Coastal Commission	San Francisco
California Historical Society	San Francisco
Calpine Geothermal Visitor Center	Middletown
Chabot Space and Science Center	Oakland
Children's Discovery Museum	San Jose
China Camp	San Rafael
Classroom Safari	Petaluma
Clayton Valley Pumpkin Farm	Clayton
Coyote Point Museum	San Mateo
Crissy Field- GGNRA	San Francisco
Crow Canyon Gardens	San Ramon
Dairy Council of California	Oakland
Davis Street Education Center	San Leandro
Deer Hill Ranch	Lafayette
Diablo Nature Adventures	Walnut Creek
Dolphin Charters	El Cerrito
Earth Island Institute Kids for the Bay	Berkeley
Earthcapades	Pacifica
East Bay Depot for Creative Reuse	Oakland
East Bay Vivarium	Berkeley
EBMUD Water Conservation	Oakland
EBMUD Watershed & Recreation Division	Orinda
EBRP: Ardenwood Historic Farm	Fremont
EBRP: Black Diamond Mines Regional Preserve	Antioch
EBRP: Coyote Hills Regional Park	Fremont
EBRP: Crab Cove Visitor Center	Alameda
EBRP: Ridgelands Naturalist Programs	Alameda
EBRP: Sibley Volcanic Regional Preserve	Oakland
EBRP: Sunol/Ohlone Regional Wilderness	Sunol
EBRP: Tilden Regional Park	Berkeley
Edible Schoolyard at MLK Jr. Middle School	Berkeley
Exploratorium	San Francisco
Farallones Marine Sanctuary Association	San Francisco
Farm Fresh Produce	Mountain View
Folsom Powerhouse	Folsom
Fort Mason- GGNRA	San Francisco
Fort Point National Historic Site- GGNRA	San Francisco
Friends of the Estuary	Oakland
Friends of the Monarchs	Pacific Grove
Golden West Women Flyfishers	San Francisco
Habitot Children's Museum	Berkeley
Half Moon Bay State Beach	Half Moon Bay
Hall of Health Museum	Berkeley
Hayward Shoreline Interpretive Center	Hayward
Headlands Institute	Sausalito
Hearst Museum of Anthropology	Berkeley
Heather Farms Garden Center	Walnut Creek

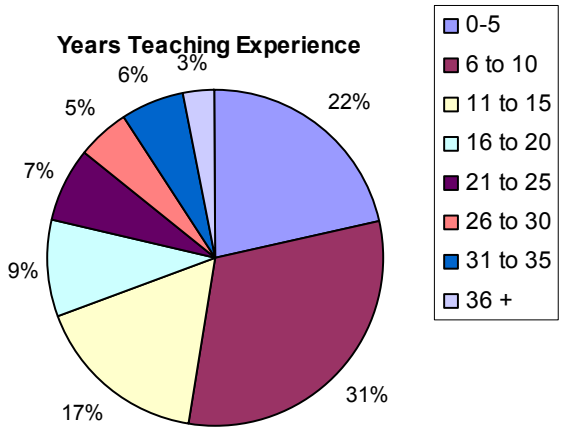
Hidden Villa	Los Altos Hills
Hiller Aviation Museum	San Carlos
Hostelling International	San Francisco
Joan's Farm & Pumpkin Patch	Livermore
Junior Center of Art and Science	Oakland
Junior Master Gardener Program	Ventura
Kaiser Educational Theatre Programs	Oakland
Lawrence Hall of Science	Berkeley
Lawrence Hall of Science-M.A.R.E.	Berkeley
Lindsay Wildlife Museum	Walnut Creek
Living Science Foundation, Inc.	Redwood City
Mad Science	Newark
Madeleine Dunphy	Oakland
Marina Education Programs	Berkeley
Marine Mammal Center Marin Headlands	Sausalito
Marine Science Institute	Redwood City
Marshall's Farm	Napa
Math Science Nucleus	Fremont
McClelland's Dairy	Petaluma
Merritt College Landscape Horticulture Department	Oakland
Monterey Bay Aquarium	Monterey
Monterey Whale Watching Cruises	Monterey
Mount Diablo State Park	Clayton
Muir Woods- GGNRA	Mill Valley
Museum of Paleontology	Berkeley
Nancy Schimmel	Berkeley
NASA Ames Research Center	Moffett Field
Natural Bridges State Park	Santa Cruz
Oakland Museum	Oakland
Oakland Zoo	Oakland
Old Borges Ranch	Walnut Creek
Palo Alto Baylands	Palo Alto
Pigeon Point Lighthouse	Pescadero
Point Reyes Bird Observatory	Stinson Beach
Point Reyes National Seashore	Point Reyes Station
Port of Oakland	Oakland
Randall Museum	San Francisco
Rotary Nature Center	Oakland
San Francisco Bay National Wildlife Refuge-Alviso	Newark
San Francisco Bay National Wildlife Refuge-Fremont	Newark
San Francisco Maritime National Park	San Francisco
San Francisco Zoo	San Francisco
Science Adventures	Huntington Beach
Science Discovery Workshop	Woodacre
Semifreddi's	Emeryville
Seymour Marine Discovery Center	Santa Cruz
Six Flags Marine World	Vallejo
Slide Ranch	Muir Beach
Spring Hill Cheese	Petalulma
Strybing Arboretum	San Francisco
Sulphur Creek Nature Center	Hayward
The Bone Room	Berkeley
The Plant Doctor	Sacramento
The Tech Museum of Innovation	San Jose
Tiburon Audubon Center	Tiburon
Tony Lema Golf Course	San Leandro
UC Botanical Gardens	Berkeley
UC Cooperative Extension-Alameda County	Alameda
Wildcare Terwilliger Nature Education	San Rafael
Wildlife Associates	Pacifica
Wings in the Night Educational Programs	Novato
Yosemite Institute	Yosemite

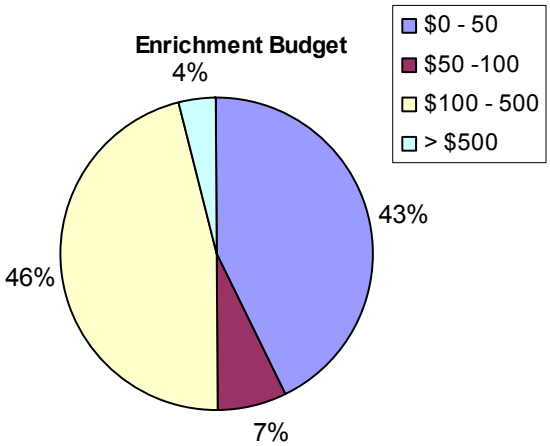
Total: 128

Appendix 3: Summary of Teacher Data



	Classtime	prep time	money	materials	help	training	mentoring	modeling
teachers	344	359	339	394	287	248	148	261





Appendix 4: California Science Content Standards for K-5

	EARTH SCIENCE	LIFE SCIENCE	PHYSICAL SCIENCE
KINDERGARTEN	*The Earth is composed of land,air and water.* 1) Earth has different landforms, **characteristics of landforms** (mountains, oceans, valleys, rivers, deserts, local landforms - ocean, Mt Tam) 2) **Weather changes** daily and seasonally affecting us all 3) Many of **Earth's resources are used everyday and some resources can be conserved**	*Different plants and animals inhabit Earth.* 1) You can **observe and describe appearance and behavior** of different plants and animals (similarities, differences of major groups) 2) **Stories about plants and animals are sometimes different from reality** 3) You can identify **major external structures of common plants & animals** (stems, leaves, roots, arms, legs, wings)	*Properties of materials can be observed, measured,predicted.* 1) You can describe objects' **materials** (paper, cloth, clay) **and physical properties** (shape, size, weight, buoyancy, flexibility, color, magnetism, texture) 2) **Water can change from liquid to solid and back again.** 3) **Water evaporates,** escaping from an open container, but remaining inside a closed container.
FIRST GRADE	*Weather can be observed, measured, described.* 1) You can **use simple tools to measure weather & record changes (**thermometer, wind vane) 2) **Weather changes day to day, but trends are predictable** during a season 3) **Sun warms** land, air and water	*Plants and animals meet needs in different ways.* 1) **Different external features of living things (LT) help them thrive** in different environments 2) **Needs of living things** (water for plant & animal, food for animals, light for plants) 3) **How animals meet needs** (using other LT for food, shelter) 4) **Food and teeth shape**: You can tell what many animals eat from the shape of their teeth (sharp eats meat, flat eats plants) 5) **How plants meet needs** (roots, leaves, leaf shape)	*States of Materials* 1) **Solids, liquids, gases** have different properties 2) Substances' **properties change with mixing, cooling, heating**
SECOND GRADE	*Earth is made of materials with distinct properties that provide resources for human activities.* 1) **Rocks** have different **physical properties** and are made of different combinations of **minerals** 2) **Breakage and weathering** create smaller rocks 3) **Soils**, created from rock & organic materials, differ in color, texture, water retention, ability to support growth 4) **Fossils** provide evidence about ancient life, scientists study fossils to learn about history 5) We get **resources from rock, water, plant, soil**, to meet our needs for food, fuel, shelter	*Plants and animals have predictable life cycles.* 1) **LT reproduce their own kind**, offspring resembles parents 2) Different animals have different **life cycles** 3) **LT inherit characteristics and respond to environment** 4) **Individuals of one kind can vary** within any population 5) **Plants are affected by environment** (germination, growth, affected by light, gravity, stress) 6) **Flowers and fruits** are associated with **plant reproduction**	*Motion of objects can be observed and measured.* 1) **Positions can be described** (relative to objects or background) 2) **Motion can be described** (observe position change over time) 3) **Motion can be changed with force** (push, pull, size of change is related to strength or amount of force) 4) **Simple tools and machines can apply force** (shovels, pulleys) 5) **Objects fall** to Earth unless held up 6) **Magnets** can apply force to move some objects 7) **Sound** is vibration, describe with pitch and volume
THIRD GRADE	*Objects in the sky move in regular, predictable patterns.* 1) **Patterns of stars** stay the same although they appear to move across sky nightly and different stars are visible seasonally. 2) **Moon's appearance changes** in a predictable four-wk cycle 3) **Telescopes** magnify distant objects in sky, there are many more stars than can be seen with eye alone 4) Earth **orbits** sun with other planets, Moon orbits Earth 5) **Position of sun in sky** changes during day and seasonally	*Adaptations in physical structure or behaviour can improve an organisms chance for survival.* 1) **Structures of LT help them grow, survive, and reproduce**. 2) There are **diverse life forms in different environments.** 3) **LT change the environment they live in**, some changes have bad effect on organism, some have good effects 4) **When environment changes, LT respond** (may be able to survive and reproduce or may die or move to new environment). 5) **LT can disappear from the Earth**, some modern species resemble historic species (dinosaurs and lizards, ferns, some trees)	*Energy and matter have multiple forms and can be changed.* 1) **Energy comes from Sun to Earth** in the form of **light**. 2) **Energy can be stored** in many forms (food, fuel, batteries) 3) **Energy can be converted to motion and heat** by living things and machines 4) **Energy can be carried** in waves (water waves, sound) electric current, and moving objects 5) **Matter has three states (solid, liquid, gas) that change when energy is added** (heating to evaporate or melt) **or removed** (cooling to freeze solid) 6) **Combining substances can create new substances with different properties** 7) **All matter is made of atoms**, particles too small to be seen with the naked eye, not earth, wind, fire, and water as once thought 8) Experiments have revealed **many kinds of atoms or elements**
	October, 1999		*Light has a source and travels in a direction.* 1) Sunlight can be blocked to create **shadows** 2) **Light is reflected** from mirrors and other surfaces 3) The **color of light** striking an object affects how our eyes see it 4) **Vision**:We see objects when light traveling from an object enters our eye.

	EARTH SCIENCE	LIFE SCIENCE	PHYSICAL SCIENCE
FOURTH GRADE	*Properties of rocks and minerals reflect the processes that formed them.* 1) You can **tell igneous, sedimentary, metamorphic rocks apart** by their different properties and different methods of formation, **the rock cycle** 2) You can use a diagnostic property table to **identify common rock-forming minerals** (quartz, calcite, feldspar, mica, hornblende) **and ore minerals**.	*All organisms need energy and matter to live and grow.* 1) **Plants are the primary source** of matter and energy entering most **food chains** 2) **Producers and consumers make up food chains and food webs**, **competing** for resources in ecosystem (herbivores, carnivores, omnivores, and decomposers) 3) **Decomposers recycle matter** from dead plants and animals (includes many microorganisms, fungi, insects)	*Electricity and magnetism are related effects that have useful applications in everyday life.* 1) You can **build series and parallel circuits** with wires, batteries and bulbs 2) You can **build a simple compass** to detect Earth's magnetic field 3) Electric currents produce magnetic fields, **build simple electromagnet** 4) **Electromagnets are used** to construct electric motors, generators, and simple devices (doorbells) 5) **Behaviour of electrically charged objects** (repel, attract) 6) **Magnets have two poles that react to each other** (north, south, like poles repel, unlike poles attract) 7) **Electrical energy can be converted to heat, light, motion** (electrical cars and trains, power to homes)
	Waves, wind, water, and ice shape and reshape the Earth's land surface. 1) There are **slow <u>and</u> rapid processes that change the Earth** (erosion, landslide, volcanoes, earthquakes) 2) **Natural processes break down rocks into smaller pieces** (freezing/thawing, root growth) 3) **Moving water erodes landforms**, rearranging rocks, pebbles, sand, and silt **(weathering, transport, deposition)**	*Living organisms depend on one another and their environment for survival.* 1) **Ecosystems** include both living and non-living components (organisms, soils, climate, etc) 2) **In each environment some organisms thrive, some do less well, and some cannot survive at all.** 3) **Relationships between plants and animals** (pollination, seed dispersal, animals rely on plants for food and shelter) 4) **Role of microorganisms** (beneficial, most are not "germs")	
FIFTH GRADE	*Water on Earth moves between the oceans and land through the processes of evaporation and condensation.* 1) **Most of Earth's water is salt water** in oceans which cover most of the Earth's surface 2) When liquid water evaporates it turns into **water vapor** and can reappear as liquid when cooled, or solid if cooled below **freezing point** 3) **Water vapor moves in air**, **can form clouds or fog** (tiny droplets of water or ice) and **can fall** to Earth as rain, hail, sleet, or snow 4) **Fresh water is limited** (located in rivers, lakes, underground sources and glaciers), and can be made more available to meet needs through **recycling and avoiding waste**. 5) Your water comes from particular surface and/or groundwater supplies (**local community water sources**) ***(Earth Science continued next page)***	*Plants and animals have structures for respiration, digestion, waste disposal, and transport of materials.* 1) **Multicellular organisms have specialized structures** 2) **Blood circulatory system** (heart, lungs), lungs and tissues **exchange oxygen and carbon dioxide** 3) Steps and organs of **digestive system** 4) Role of kidneys, bladder in **cellular waste removal** 5) **Plant processes** and structures moving sugar, water, minerals 6) Plants use carbon dioxide and energy to make molecules of sugar and release oxygen 7) Plant and animal **cells break down sugar to obtain energy**, releasing carbon dioxide and water	*Elements and their combinations account for all the varied types of matter.* 1) During chemical reactions **atoms rearrange** into different products with different properties 2) All **matter is made of atoms**, which combine to form molecules 3) Common **properties of metals** (conductivity, pure vs combinations of elemental metals) 4) Each **element** is one kind of atom, organized in Periodic Table 5) With **instruments** you can see that atoms and molecules are discrete and in well ordered arrays. 6) **Separate mixtures** and **identify compounds** using their chemical and physical properties 7) **Properties of common molecules** (sugar,water, oxygen, etc.) 8) Just a **few elements** make all living things and most materials 9) Common **properties of salts** (sodium chloride)

	EARTH SCIENCE	LIFE SCIENCE	PHYSICAL SCIENCE
FIFTH GRADE continued	*Energy from the sun heats the Earth unevenly, causing air movements resulting in changing weather patterns.* 1) **Wind, convection currents**, are air movements caused by uneven heating of the Earth 2) **The oceans influence the weather and the water cycle plays a role in weather patterns** 3) There are several **causes and effects of severe weather** (hurricanes, typhoons, tornadoes) 4) You can **use weather maps & data to predict weather, forecasts depend on** many variables 5) Earth's **atmosphere exerts a pressure**, decreasing with altitude, that is equal in all directions at any point.		
	The solar system consists of planets and other bodies that orbit the sun in predictable paths. 1) The **sun, an average star**, central and largest body in solar system, made of hydrogen and helium 2) **Solar systemcontains:** Earth, moon, sun, eight other planets & their satellites, smaller objects (comets, asteroids) 3) Path of a planet (orbit) is due to **gravitational attraction between** Sun and planet.		
			Prepared from 1999 California State Science Standards by
			Community Resources for Science *practical support for great science teaching* **663 13th Street, Oakland, CA 94612** **510.273.0290 • www.crscience.org**

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