Bioshelter Primer

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THE INTENTIONAL DESIGN OF MICROCOSMS

I INTRODUCTION

The process of creating a microcosm of life, protected and nurtured by an architecture that is responsive to its environment, is at once exhilarating and sobering. The realization of the human role within the mystery and complexity of biological systems comes slowly. As designers and maintainers of bioshelters, we are attempting to unravel the complex relationships which exist between living organisms and their substrates, between biological organizations and their environment, and between human actions and their consequences. In bioshelters we have a unique opportunity for investigating some of these relationships on a human scale, simultaneously providing ourselves with year-round food supplies.

All of the plants, animals, and micro-organisms used in agriculture have developed, over time, in a matrix of physical and biological conditions that influence their present suitability for human manipulation and use. Where human communities are mindful of their physical dependence on the health of their landscape, symbiotic partnerships develop. When human communities ignore or forget basic ecological dynamics, the biological environment that protects and nurtures them deteriorates, often resulting in deserts or floods, droughts or famine. The rate at which large-scale degradation can occur is frightening. In Costa Rica recently, large regions have evolved from tropical forest to desert in less than a decade. if humanity is to survive, we must learn to recognize and respect successful ecological patterns, whether in the wilderness, a garden, or a bioshelter. Sensitivity to the dynamics of the whole is crucial. The investigation of biological microcosms is one path to the kind of sensitivity required to comprehend wholes. It is hoped that the subsequent knowledge will enable us to act more wisely in the world.

The reality of a winter food garden in northern climates has become possible for significant numbers of people only in this century. Enclosed plant communities range from sterile commercial monocrop factory-greenhouses to exquisite and exotic zoological

gardens. New Alchemy's development of bioshelters is part of a long-range program for year-round fresh food production. We are trying a number of methods of extending the annual growing season. We are working with cold frames, solar-based cloches, and several kinds of greenhouses for vegetable and aquaculture gardening. For mid-winter conditions, research is now centered on medium-sized, solar-heated structures which enclose an internal garden ecosystem of plant, animal, and soil communities. The aim is to develop an interesting, productive microcosm of vegetables, vines, insects, trees, and aquaculture ponds for winter food production.

The Cape Cod and Prince Edward Island Bioshelters, which we call Arks, are comparable in size to small, family-operated, commercial greenhouses. Each was designed in response to its particular climate and is intended to require no fossil fuels for maintaining its internal climate. The Cape Cod Ark is limited to vegetable and fish production and has appropriate climate control facilities to sustain it. The Prince Edward Island Ark includes not only agriculture and aquaculture, but also a residential area for a family, which takes advantage of the heating and climate control of the rest of the structure. Similar architectural and ecological strategies are employed in both Arks, many of which will be discussed.

II. ARCHITECTURAL STRATEGIES

The general appearance of the Cape Cod Ark is shown by accompanying architectural drawings and photographs. The major features are calculated to stabilize the effects of external weather oscillations and to form diverse internal microclimates of temperature, light and moisture conditions. The ecologist, Eugene Odum, suggests that, in nature, the great diversity and organic structure of a mature ecosystem have survival value in the resulting ability to achieve some measure of stability or homeostasis, but that, in a fluctuating physical environment, this is at the cost of a decrease in net productivity. We are testing the idea of using the physical structure of the Ark to supply the desired environmental stability of a mature ecosystem, while maintaining the productivity of a "young" one. By sustaining a more stable internal climate comprised of many diverse microclimates, we are able to grow a large variety of food plants in the winter season. This results in a more diverse biotic community in the Ark and in an interesting winter diet for us. Architectural elements such as terraces, aquaculture ponds, stone walls, and vertical trellises all contribute to the structural complexity of the interior.

The major components of the building include:

Solar Membranes. The south-facing roof and parts of the east and west walls are formed of double-glazed fiberglass which allows light to enter the structure but retains warm air. The fiberglass tends to diffuse incoming light, spreading it evenly to all corners of the growing area. This characteristic avoids "burning" of delicate greenhouse plants in seasons of intense radiation. The fiberglass also admits some of the natural ultraviolet light, important in the control of fungus. Curved into transparent cylinders, the same material is used in solar aquaculture ponds, because it allows for maximum photosynthesis and dense algae growth.

Passive Tbermal Mass. Only a fraction of the light entering the Bioshelter is used directly by the plants for photosynthesis. Much of it turns to heat and is used in the evaporation of water. Some is absorbed as heat by soil and plants. The absorbed heat is valuable in warming the plants' microclimate at night. We have tried to maximize the mid-day passive heat absorption process to use for later night warming in the following ways:

(1) The retaining walls of the vegetable terraces are made of field stone.

(2) The high north foundation wall and the walls of the rock storage bin are of solid concrete and are insulated from the outside soil to reduce conductive losses. These walls absorb heat from both direct sunlight and warm daytime air.

(3) The solar aquaculture ponds used in the Ark are important units of heat

storage.

Previous experience with these ponds in greenhouses where the ponds are the major thermal mass has shown that a body of water is remarkably effective at moderating the diurnal temperature cycle. We are now discovering that aboveground transparent ponds containing an algae culture are even more effective than in-ground ponds. The solar ponds have a better absorbing surface in low-angle winter sunlight. Light entering at all levels allows thermal mixing instead of thermal stratification as in in-ground ponds. At night, more heat enters the air by convection because less is lost into the ground by conduction. By careful placement of solar ponds, one can create special temperature zones for tender plants, and the rate of heat release at night can be regulated by double-glazing the pond or using a lid.

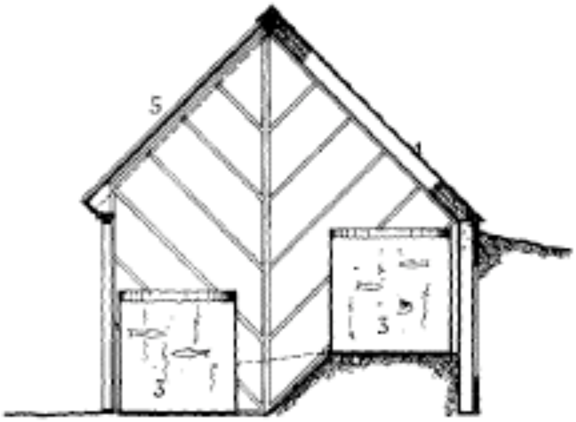
(4) The open concrete pond absorbs light and heat and the warmed water is used for irrigation.

Active Diurnal Heat Cycling. Even with large amounts of thermal mass in the structure, on bright sunny days there is often a surplus of heat that accumulates in warm air near the ceiling. The warm air is drawn by a fan into an air duct in the north wall and is blown into a large concrete bin filled with fist-sized stones. As the warm air passes through the matrix of stones, it loses some of its heat to the stones before being exhausted back into the building again. During the warm portion of the day, excess heat is stored in the stones, keeping the plants from overheating. Halfway through the next night, when the passive thermal masses have already cooled, the fan comes on and circulates air through the warm stones, then into the greenhouse in the pre-morning hours when it is most needed.

Light Reflecting Ceiling. The sloping inner surface of the insulated north roof is painted white to reflect light downward onto the plant canopy. In some northern greenhouse tests of this design, light intensities at the plant canopy were greatly increased due to the reflection.

Convective Venting. In the summer months when no heat storage is required and excess heat must be removed, ventilation panels at the peak of the roof are left open and hot air rises from the building by convection and is replaced by air entering through the open doors. If necessary, the fan can actively exhaust hot air to the exterior.

CROSS SECTIONS OF THE CAPE COD ARK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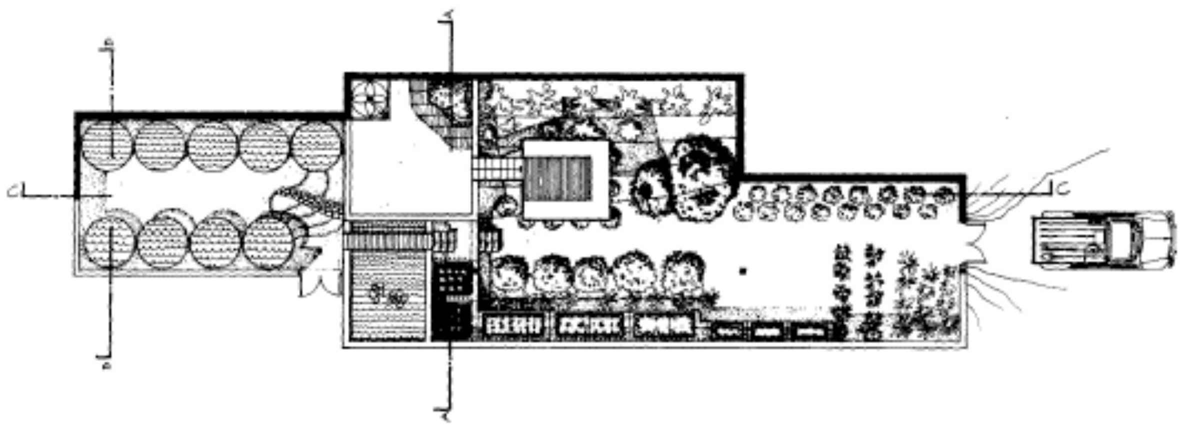
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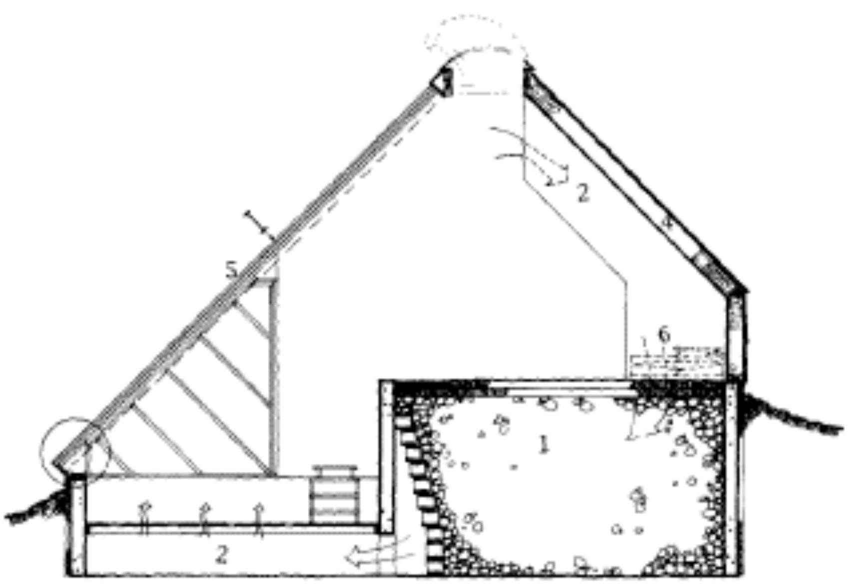
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III. BIOTECHNICS

Within the confines of the climate-modifying structure just described, we have begun to assemble an ecosystem of plant, animal, and soil communities which will be productive, healthy, and beautiful. Many of the basic principles of ecosystem structure and function have been formulated by diligent scientific research, but no comprehensive design theory relating humans, agriculture, and nature has been proposed that is directly applicable to our task. We are engaged, then, in a subtle challenge, to understand the apparent workings of the natural world deeply enough to live and to co-exist permanently and creatively within it. Speculating on the possibility of such a symbiosis between the earth and humankind, Rene~ Dubos is optimistic: "Symbiotic relationships mean creative partnerships. The earth is to be seen neither as an ecosystem to be preserved unchanged nor as a quarry to be exploited for selfish and short-range economic reasons, but as a garden to be cultivated for the development of its own potentialities of the human adventure. The goal of this relationship is not the maintenance of the new status quo, but the emergence of new phenomenon and new values. Millennia of experience show that by entering into a symbiotic relationship with nature, humankind can invent and generate futures not predictable from the deterministic order of things, and thus can engage in a continuous process of creation." The reciprocal transformation required to evolve such a symbiosis implies that humans must learn and learn well their responsibilities to the whole of which they are part. Some general patterns in the workings of nature can guide us. The accepted indicator of health in natural ecosystems is diversity, diversity of species, niches, food chains, and so on. Most present agricultural ecosystems are purposely *not* diverse, since high net productivity of food demands a simplified food web with humans occupying many of the top positions.

The immediate aim of agriculture, then, is to act upon an ecosystem to promote a net productivity of food and materials in excess of that required within the ecosystem by its members. The wider task is to accept that humans are *in* the ecosystem (as large omnivores), and to discover which patterns of behavior within the ecosystem offer the chance of a permanent ongoing co-existence between themselves and the earth, sustaining both human culture and all other species. Possible models for such continuing co-existence would be those human cultures which have remained in one region for centuries without causing the progressive degradation of their supporting ecosystem. Absolute failures are easy to observe and well documented. Successes are difficult to ascertain, but potential candidates exist at two interesting extremes. One is the slash and burn agriculture of the Maring people in the New Guinea rain forests, in which the forest ecosystem is allowed to remain complex doing

the regeneration and recycling work essential to maintain fertility. The other extreme is labor-intensive garden agriculture in Southeast Asia in which people regenerate domesticated species and recycle nutrients manually within the ecosystem. Conceptually, the bioshelter tends to resemble the latter, insofar as intense care and management of carefully selected food plants maintain a stable "young" ecosystem, completely domesticated yet highly productive. In such an agriculture, each species is selected for its value to humans and is continuously sustained by them.

A. MICROCLIMATES

In constructing the bioshelter ecosystem, we have chosen valued traditional food plants as major species and have tried to calculate the optimum microclimate and required auxiliary species for each one. For instance, some fruiting vegetables need pollinating insects while others require predators for aphids. The entire garden ecosystem of food plants, insects, soil organisms, etc., by virtue of its historical domestication is simplified yet productive. By providing and encouraging essential regulating species and discouraging competitive or non–adapting ones, a new community can be formed which is adapted to the bioshelter conditions.

Each garden organism is somewhat specialized in such habitat requirements as root depth, soil temperature, light/shade preferences and moisture. Therefore the initial design criterion for the Ark was that it provide a moderate over–all climate with numerous microclimates, so that a wide range of food plants could be grown. Examples of these microclimates include:

Terraces. in the smaller prototype of the Ark we observed that a general temperature gradient existed; cold air from windows and cracks settled on the floor, while warm air rose to the ceiling. The few degrees difference in soil and air temperature was sufficient in the same light conditions to produce green peppers on a raised bed but not on the floor. In the Cape Cod Ark there are several terrace levels. On ground level, we are growing the most hardy vegetables, such as lettuce, chard, kale, and parsley. On middle levels, we grow head lettuce, snow peas, green beans, and herbs. On the high terrace during spring and fall months are tomatoes, peppers, cucumbers, and bamboo.

Terrace Walls. The retaining walls of the terraces are of field stone, each containing numerous pockets of soil for plants. Because the stones are warmed by the sun daily, the plants there have a slightly drier, warm zone. Some of the clinging or hanging plants used are New Zealand spinach, strawberries, nasturtiums, thyme, parsley, and other herbs. Another retaining wall, this one below the main aquaculture ponds, is of concrete blocks set with their holes running horizontally. This area is dry and shady; plants growing in these soil pockets are herbs, ivy, comfrey, vetch, purslane, and other fish foods.

North Wall Trellises. The high concrete north wall creates a vertical warm zone for climbing and espaliered plants. The wall remains warm in the evening, where tomatoes, malabar spinach, figs, grapes, and cucumbers grow.

Heat Storage Bin. A unique area for subtropical species is on top of the beat storage bin, which is at a generally warm elevation and is warmed from below by stored heat. On this surface are many tropical and subtropical species, planted permanently or temporarily overwintering. Several plants from New Alchemy's Costa Rican Center are there, including perennial sweet peppers, lemon grass, papayas, naranjila, and hibiscus. in addition, there are dwarf citrus, dwarf cherry, a large rosemary, and various palms and ornamentals.

Seedling Bench. Circulating air from the heat storage bin is distributed to the Ark through a long low air chamber along the southern wall. The surface of this chamber is ideal for the propagation of vegetable seedlings, tree cuttings, and tree seedlings, as it receives bottom warmth from the air passing beneath. On this surface we grow seedlings for periodic winter replacements, and large numbers of seedlings for spring use. This bench also serves as a potting area.

Compost. Any weeds and vegetable waste not fed to fish are composted in one corner of the ground level. This is a somewhat controversial practice in terms of greenhouse sanitation, so until we have further evidence, we shall compost wastes indoors but use the compost outside. It remains a slow, constant source Of C02 and heat as it decomposes, and provides a home for crickets, spiders, beetles, sowbugs, and other insects. *Herb Area.* One portion of the growing area has been reserved as a permanent habitat and food source for predatory and pollinating insects. It contains many flowering herbs, wild flowers, and gardenedge plants to provide continuous shelter, nectar, and pollen. Within this area there is also a tiny pond for use by insects, toads, and other residents.

Open Pond. The garden area is irrigated with water from the concrete pond. The water is partially warmed through the wall that divides it from the heat storage bin and is a biotic reservoir of aquatic species for aquaculture purposes. In it are a variety of plants and animals, including several species of fish, *Azolla,* water hyacinths, turtles, a frog, freshwater mussels, and crayfish.

Solar Aquaculture Ponds. At various locations in the garden area we have placed solar aquaculture ponds to provide a localized microclimate for plants that might benefit from warmth radiated from the ponds at night. By careful positioning of one or more ponds near a wall, specialized zones for sensitive plants can be created.

B. BIOTA SELECTION

In the selection of organisms for a bioshelter, some knowledge of the dynamics of an outdoor garden is helpful. We have tried to establish a polyculture of garden vegetables, herbs, flowers, and several small trees and vines together with obvious associated pests and predators in a rich, biologically-active soil. While all of the interactions of combined organisms cannot be predicted, patterns that appear in successful gardens can be approximated.

Soil. The soil in the growing area and terraces is comprised of a twenty-four inch deep mixture of field topsoil, leaf mold, and rotted manure, with small inoculations of garden, meadow, lakeside, and forest soil organisms. The health of soil life is more difficult to observe than that of larger organisms, but the soil's function of nutrient processing and recycling is vital to the long-term performance of the ecosystem. The soil community may also be crucial to the maintenance of the gaseous equilibrium of the internal atmosphere. Earthworms were added to the soil to aid in mixing and decomposing the initial rough organic matter and to distribute soil microorganisms. Earthworm density may eventually be used as an indicator of the soil condition.

Plants. The majority of plants tested over the past two winters has been food plants - garden fruits and vegetables. Other categories have been herbs, tropical tree seedlings, ornamentals, houseplant cuttings, and vegetable seedlings. A list of all plants tested appears in Appendix II. Varieties which thrive and produce well are being tested for optimum microclimate and growth periods; varieties which sicken or are overwhelmed by pests are removed. Outstanding successes in Cape Cod conditions are noted in Appendix II. Another group of plants, those that spontaneously appear from weed seeds, are not listed, but include hairy vetch, purslane, clover, and buckwheat.

Animals. Animals include humans, soil organisms, insect pests and predators, toads, birds, bees, wasps, spiders, and many others that are obvious members of garden fauna. Some were intentionally introduced, but most entered on plants, in soil, or as colonists during the fall. Several intriguing immigrants are: a tree frog which provides jungle sound effects, paper wasps which perform most pollination duties, and visiting birds who drop in occasionally for a bite to eat. An annotated list of introductions and observed immigrants appears in Appendix III.

An interesting analogy on the population dynamics of the Ark ecosystem is that of the species on an island located near a mainland. Population ecologists now theorize that newly formed islands absorb colonizing species rapidly until an equilibrium is reached between immigration and random extinction of species on the island. Mathematical models of this theory have been

verified in several instances and may be appropriate in understanding a bioshelter.

Pseudo -Organisms. In a sense, a solar aquaculture pond could be compared to a new type of organism, exhibiting mixed characteristics of a cell, an organism, and an ecosystem. It admits light, has an internal photosynthesis/respiration process and a "body" temperature and metabolism, and is linked to the gaseous equilibrium of the bioshelter atmosphere. Distinctions between levels of biological organization become hazy when analyzing such a community.

IV. INVESTIGATION: PURSUING THE STATE OF THE ARK

Presently we are engaged in several directions of research: (1) Testing food plants for adaptivity and productivity; (2) Monitoring succession and development of new food web relationships; and (3) Investigating climate control patterns and their effect on ecosystem productivity. These activities are closely interrelated and the methodology is evolving with the structure. The main concepts of each investigation will be touched on briefly.

Testing Food Plants. The food production aspect of the bioshelter is considered part of a larger agricultural process including summer gardens, food forests, and animal husbandry. The function of the present bioshelter in that scheme is to produce a source of winter vegetables, a year-round supply of fish protein, vegetable seedlings for summer gardens, and valuable fruit and nut seedlings. Of particular interest to us is whether such an integrated agriculture can sustain a family or small group by supplying their food needs with enough surplus to market to their community.

We are concentrating on vegetables which are enjoyed fresh or which cannot be easily stored from the summer. By monitoring growth rates and production periods, we hope to develop a seasonal planting sequence to supply constant fresh food and seedlings as needed. Certain crops grown commercially in northern greenhouses are being analyzed to discover whether bioshelter production could be competitive with greenhouses using fossil fuels.

Monitoring Succession. Soon after the construction of a microclimate and the introduction of desired species, a natural phenomenon occurs of which all gardeners are painfully aware - pests and unexpected weeds appear. Since we do not completely understand the functions of minor organisms, and indeed are often not even aware of their existence, it is wise to respect their presence until it becomes apparent that they cause a difficulty. We have allowed most species to remain observed but unmolested as we determine their roles. Weeds in the soil are allowed to grow until it appears that either the root system or leaf canopy is interfering with a food plant. The weed is then either removed or dug into the soil at that spot.

Undoubtedly the presence of the weed in the soil stimulates some segment of soil microorganisms, and such diversity of process may be valuable. Yearly applications of outdoor garden compost and seasonal migrations of insects guarantee a continuous influx of species over time, and careful observation should reveal new relationships as they arise.

Climate Control: Fine Tuning. One type of climate control is the establishment of temperature microclimates. This is done through permanent architectural elements and through variable control of active heat storage and air circulation. A further possibility is an auxiliary wood stove for cold, cloudy periods. The mechanical and fuel energy required for these controls, and the resulting benefit in productivity, is of great importance in determining the ultimate effectiveness and viability of bioshelters.

Other fundamental questions yet to be answered include: the overall effect of great or small tempera

ture fluctuations on the productivity of the ecosystem; the importance of air movement to productivity; the addition and optimum utilization of auxiliary heat. We are developing instrumentation to help us begin to answer these questions.

V. EXPLORATIONS

A great many facets of bioshelters remain to be explored. Fields of research which New Alchemy is initiating are:

Sheltering Bioshelters. Biological climate modification of architectural structures using winter windbreaks and summer shading with vines and trees.

Plant Selection. Developing plants genetically adapted to bioshelter existence.

Computer Modeling. Use of instruments and mathematics to test predictive models of improved bioshelters.

Wind and Solar Power Sources. Development of windmill compressed air for mechanical tasks and solar cells for electrical controls.

Human Bioshelters. New hybrids between human housing and bioshelters, in which each benefits from the sharing of solar energy and climate moderation.

The Cape Cod Ark is an early stage in the development of the bioshelter concept. We are just beginning to sense its potential as a catalyst in humankind's understanding of nature. The most captivating vision is one which includes people in the system, as is being tried in the Prince Edward Island Ark in Canada. To assume the conscious responsibility of the ecosystem that sustains one is a fundamental change in awareness that has been sadly lacking in the industrialized west. Perhaps by this route, by first contemplating and internalizing the microcosm, larger changes can follow.

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Ark – Bioshelter I – Cape Cod Microfarm

STRUCTURE
Length 90, 27.43 m)
Maximum Width 28' 8.5 3 m)
Floor Area 1950 sq. ft. (181.16 m2)
Adjacent Aquaculture Courtyard 1200 sq. ft. (111.5 m2)
(Not Shown in Illustration)
451 Angle South Facing Roof2000 sq. ft. (185.89 m2)
Vertical South Facing Roof160 sq. ft. (14.86 m2)
Translucent Ends 320 sq. ft. (29.91 m2)
Laboratory Pedestal 72 sq. ft. (6.7 m2)

AQUACULTURE

Pool 2,872 gallons (10,870 liters)
9 Interconnected Solar Ponds In Interior 6,610 gallons (25,0201iters)
21 Interconnected Solar Ponds In Exterior Courtyard 15,422 gallons (58,380 liters)

Total Solar Pond Aquaculture Facility22,032 gallons (83,400 liters)

CLIMATE

Air Circulation – 3'Diameter 1 hp Fan
Hot Air Collection –Subsoil Duct Return
Venting 200 sq. ft. (18.58 m2) On The Peak Plus Doors and Vents Along South Side
Hot Air Storage (Rocks) 43 cu. yds. (181.16 m3)
Translucent Sloping Roof
Suspended 5' Wide (1.52 m)
Fiberglass in Catenary Curve. Double Walled Separated by 1" (2.54 cm) Air Space
Material: Kalwall Corporation Sun–Lite Premium 0.040" Thickness (0.10 cm)
Single Layer Ultra–Violet Transmission 5% @ .33 microns
85% @ .38 microns
Visible Light Transmission 90+% (.38 –.76 microns)
Short Wave Infra–Red~ Most Transmitted (.76–2.2 microns)
Long Wave Infra–Red: Most Blocked and
Retained in Interior
(2.2 – 50 microns)
North Walls and Roof
1/2" Plywood on each Side 6" (15.24 cm) Fiberglass
Insulation
Shingled
Foundation Insulation: 2" (5.08 cm) Polyurethane

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APPENDIX II – PLANT LIST

The following plants have been grown and observed in the Bioshelter and food plants for potential use in bioshelters.

.*Ajuga – W*
Aloe vera – S, H
Alyssum – W
Artichoke, Globe
Avocado– T
Azolla
Bamboo – T
Basil, Sweet – H
Basil, Purple
Beans, Green
Beans, Purple Pod
Beans, Scarlet Runner
Beans, Broad Windsor
Beet
Begonia, Strawberry
Borage – W, H
Broccoli
Brussels Sprouts
Cabbage – C
Chamomile, German – H
Chard, Swiss – C
Cherry, Catalina
Chinese Cabbage – C
Chives, Garlic – C
Coleus
Comfrey – H
Crown of Thorns
Cucumber
Date
Dill – H
Eggplant
Endive – C
Fern, Boston
Fig – V, T
Fig, Weeping – T
Garlic – C, H
Geranium
Grape – V
Hollyhock
Impatiens
Ivy, Swedish
Ivy, English
Kale – C
Kohlrabi – C
Lemon, Dwarf
Lemon Grass
Lime, Dwarf
Lettuce – C
Luffa – V
Marigold
Marigold, Mexican
Marjoram
Mulberry
Nasturtiums – V, W
Naranjilla
Okra
Onions, Yellow – C
Onions, Bunching – C
Oregano – H
Otaheite Orange
Palm
Papaya – T
Parsley – C, H.
Parsnips
Passion Vine – V
Paw Paw – T
Peas
Pennyroyal – H
Peppermint – W, H
Peppers, Sweet
Peppers, Costa Rican
Petunias
Philodendron – S
Potatoes, Sweet
Purslane – W
Pyrethrum
Radishes – C
Rosemary – H
Rue – H
Sage – H
Shallots, French – C, H
Spearmint – H
Spider Plant
Spinach, Bloomsdale
Spinach, New Zealand – W, C
Spinach, Malabar – V
Strawberries – W
Sunflowers
Sweet Peas – V
Tansy – H
Thyme, Creeping – W, H
Thyme, Lemon
Tomatoes – V
Turnips
Vetch – W
Wandering Jew – W

W – Well suited to growing on vertical wall spaces
S– Shade tolerant
V – Tall plants to be trained vertically
C – Coot season food plant
H – Herb
T – Tree–sized plant

APPENDIX III – ANIMAL LIST

Terrestrial – This is a partial list, including only intentionally introduced animals and most obvious observed animals.

Ants, Black .... Observed
Bees, Honey .... Observed

Cabbage Worms .... Observed
Carolina Lizard .... Introduced
Centipedes .... Observed
Crickets .... Introduced
Earthworms .... introduced
Earwigs .... Observed
Frogs .... Introduced
Praying Mantis .... Introduced
Slugs .... Observed
Sowbugs .... Introduced
Spiders .... Introduced
Spider Mites. .... Observed
Toad, Garden .... introduced
Toad, Tree .... Introduced
Warbler, Palm .... Observed
Wasp, Paper .... Observed
Wasp, *Trichogamma prediosum* Introduced
Whitefly .... Observed

Aquatic

Bluegill	Dragonfly
Carp, Israeli	Gourami
Carp, Grass	Mussels, Freshwater
Catfish, Bullhead	Snails
Crayfish	*Tilapia*
Damselfly	Water Boatmen
Daphnia	Water Striders