DRAFT: Research Topics for the Scott Creek Watershed and Environs

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For additional information on these topics, see "Traversing Swanton Road," by James A. West
http://arboretum.ucsc.edu/pdfs/traversing-swanton.pdf

[TO ADD: seedlist, locations map, list of vouchered specimens from area]

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1. *Stachys* spp.—Underlying evolutionary mechanisms, which from an ecological perspective define the interrelationships between four taxa within one genus sharing the same watershed:

a) *S. chamissonis*—hydrologically active, year-round habitat (China Ladder Marsh);

b) *S. ajugoides*—seasonally wet, often poorly drained depressions;

c) *S. rigida* var. *quercetorum* – mesic to xeric (edge of chaparral) habitats; and

d) *S. bullata*—highly adaptive, ranging from coastal marshes, coniferous/oak woodlands, riparian corridor, and occasionally extending up to chaparral.

2. Reproductive isolating mechanisms and native bumblebee (*Bombus* spp.) versus introduced honeybee (*Apis mellifera*), comparing their overall versatility as pollinating vectors and the potential consequences of population collapse due to disease, parasites, and/or pesticides of the introduced species relative to habitat loss through agricultural conversion and/or urbanization of the native species.

What percentage of our native plant species are flexible enough in their basic floral structures to allow for indigenous replacement vectors with albeit less-effective capacities for pollen transference to offset the possible loss of the primary pollinator; and, what are the long term implications for speciation in a changing environment?

3. The roles of mammals, birds, and insects—intentional or otherwise—as pollinators/seed-dispersers and the co-evolutionary mechanisms involved.

a) Which plant species are generalists where pollinating vectors are concerned?

b) Which species have co-evolved with specific vectors? For example, *Castilleja subinclusa* subsp. *franciscana* is pollinated by hummingbirds, however *C. affinis* sensu lato is generally bee pollinated, despite the fact that this polyploid/polyphyletic complex shows evidence of *C. subinclusa* subsp. *franciscana* in its ancestry.

c) Where flower color and scent are present (e.g., with *Lupinus arboreus* and its hybrids with *L. variicolor*), do both of these traits have equal value in the formation of the fertile hybrid, or does one of these two attractants (visual, olfactory) exert a greater influence in the hybrid formation?

4. Chemical signatures (foliage and/or floral scents) as taxonomic markers, used in conjunction with other morphological features, to differentiate locally problematic species/hybrid complexes, e.g.:

- *Castilleja* (*densiflora* aff. *Orthocarpus noctuinus* Eastw.);
- *Layia* (*L. gaillardioides* and *L. hieracioides*);
- *Madia* (*M. exigua*, *M. gracilis,* and *M. sativa*);

- *Erythranthe* (*guttata* complex);
- *Monardella* (*villosa* complex);
- *Pseudognaphalium* ("gianonei" pro. sp. nov.);
- *Sanicula* ("gianonei" pro. sp. nov. and "pseudo-laciniata" pro. sp. nov.);
- *Trillium* (*chloropetalum* complex); and
- *Stachys* (evolutionary/phylogenetic relationships between *S. ajugoides*, *S. bullata*, *S. chamissonis*, and *S. rigida* var. *quercetorum* based on a comparative analysis of their chemical signatures).

5. Create a digital library/herbarium documenting the watershed's flora at all stages of development (e.g., cotyledon configuration, seed structure and patterning, etc.).

See the "Flora of Scott Creek Watershed" page on CalPoly/Swanton Pacific Ranch's website at http://spranch.calpoly.edu/plantlist.ldml?available=y where this project has been started.

6. Habitat stability versus human-induced disruptions, and the resulting increase/decrease in patterns of biodiversity, e.g.:

a) north-northeast-facing slopes overlooking Scott Creek, between Scott Creek and Little Creek bridges, with particular emphasis on the forested slopes overlooking the Swanton Pacific/Cal Poly orchard down to the Mill Creek confluence with Scott Creek; and

b) east-facing slopes overlooking Swanton valley, between the confluences of Big Creek and Little Creek with Scott Creek.

7. Palynological (pollen) studies involving core samplings taken throughout the watershed to ascertain historic changes within the local species composition, specifically, from a hydrological, palynological, and ecological perspective.

Do a comparative study of the benched/perched marshes at the southwest edge of the Western Terrace coastal prairie, between the Cowboy Shack Gulch and Lasher Marsh Gulch drainages.

a) Determine, if possible, the age(s) of the marshes, which act as "islands of biological diversity."

b) Determine the differences between current and pre-European occupancy native-species composition.

c) Conduct an inventory of shared and marsh-specific taxa.

d) Determine the role, if any, the underlying syncline plays in water storage/distribution patterns within this section of the Western Terrace.

e) Determine what influence the aeolian sand deposits have played in shaping the vegetational mosaics throughout this portion of the coastal prairie.

f) Determine what the cumulative impacts of agriculture and grazing crops have played in modifying/fragmenting the native vegetation, investigating its persistence along the non-cultivated margins, and the repository capacity of *Juncus* tussocks to act as mini-refugia.

g) Determine the ecological importance from a biodiversity perspective of the east-west alignment of the lower portions of the marsh-draining gulches between the coastal prairie and Highway 1, having mesic and xeric biotic profiles mirroring each other.

8. Investigate the geomorphic origins of the "vertical grasslands" and their value as refugia for rare taxa and holding succession in abeyance, using Lidar to define these areas of concentrated biodiversity coupled with in situ photography and biotic inventories, thus generating a baseline for in-depth reasearch projects.

9. Study the slope orientation and resulting changes in vegetation patterns (mesic versus xeric) within the same drainage system using the ocean-draining gulch systems between the Lasher Marsh Gulch and Scott Creek Marsh as examples—one of the underlying mechanisms needed to establish localized biodiversity.

10. Paralleling the co-evolutional value of fire within the chaparral ecosystem, study the importance of cyclical riparian scouring to reinvigorate the established, long-lived vegetation and increase species diversity by uncovering seeds deposited and buried decades before in sandbars and adjacent stream banks.

11. Study gene-flow patterns within a given taxon, e.g., coyote mint (*Monardella villosa,* sensu lato), which ranges elevationally from the coastal bluffs up to the chaparral and is represented in the watershed by two well-defined subspecies (see http://digitalcommons.calpoly.edu/theses/1022/).

a) Map the distribution patterns of *M. v.* subsp. *villosa* and subsp. *franciscana* and the areas where their populations overlap.

b) Investigate what underlying ecological conditions allow the two subspecies to maintain their distictive phenotypes and determinine where their ranges overlap. (Is there a breakdown in those distinctions?)

c) In terms of speciation, is subsp. *franciscana* more recently derived, and are there any mechanical or genetic barriers evolving or in place, save physical proximity, to prevent the exchange of genetic material between the two taxa?

d) Study the local *M. villosa* complex as a series of overlapping "micro-species," originally formed by the fragmentation of larger populations and through isolation and inbreeding forming several (biochemically and morphologically) distinct sub-populations.

Where two or more of the "isolates" reconnect (through some disturbance regime), intraspecific hybridization may have taken place, possibly explaining the foliar and chemical complexity displayed within some of the larger populations.

e) Are there any chromosomal differences between the two subspecies as they occur within the Scott Creek Watershed and environs and within the two subspecies themselves? Are the populations uniform as to the base number of n=20?

f) With the majority of species comprising the genus *Monardella* possessing the base chromosome number of n=21 and *M. villosa* recorded as having n=20 with subsp. *obispoensis* a tetraploid (2n=80), how do the base differences in chromosome numbers and example of polyploidy define *M. villosa* sensu lato within the phylogeny of the genus?

g) How do the local populations of both subspp. *villosa* and *franciscana* compare with the type circumscriptions for both taxa?

h) Are the thicker leaves with their deeply impressed veins and complex capitula (comprising multiple "heads" with their subtending foliar bracts aggregated into one large capitulum or arranged in whorls and verticillate in appearance) indicative of higher ploidy levels. Are these manifestations restricted to the subsp. *franciscana*?

i) Along Swanton Road (between the entrance to Purdy Road down to the Casa Verde) are a series of disjunct populations of *M. villosa* aff. *villosa*, more or less within the same elevational range. Do these micro-populations constitute a cline, moving from subsp. *villosa* into subsp. *franciscana* at the mouth of the Queseria Gulch system, or are they separately derived from populations elevationally above them that currently exist or are no longer extant?

12. *Clarkia purpurea* subspp.—The flowers of *C. purpurea* subsp. *purpurea* and *C. p.* subsp. *quadrivulnera* vary both within and between populations as to contrasting pigment patterns and their placement/dimensions in terms of UV radiation absorbed or reflected and the ability of members of the Hymenoptera to perceive this part of the spectrum.

a) Is one pattern preferred over another by the prospective pollinators?

b) How does this affect both the variability within and sustainability of the populations as a whole in a changing environment?

13. *Lupinus* hybrids—

a) Document the primary hybrids locally of *L. arboreus* with *L. formosus* and *L. variicolor* and the relationship of the stabilized taxon tentatively designated *L. propinquus* to both *L. arboreus* and *L. latifolius*.

b) Determine what role, if any, have the primary hybrids played in the variability of the contributing parents through backcrossing and what evolutionary advantages/disadvantages are conferred where sympatric interfertile taxa are both perennial, but either evergreen or seasonal above ground and shrub-like versus decumbent in mode of growth?

14. Study the role of bryophytes in

a) providing a favorable micro-habitat for seed germination;

b) creating a buffer zone between exposed rock or bark formations with their potentially less than optimal pH; and

c) through their hygroscopic capabilities, capturing atmospheric moisture, particularly between dusk and dawn.

15. Study the comparative value of dissimilar types of recent and accumulated leaf litter (e.g., *Notholithocarpus densiflorus* var. *densiflorus*, *Arbutus menziesii*, *Sequoia sempervirens*) in mitigating the erosive power of heavy and often prolonged rainfall in unstable areas.

16. Study the cumulative capacity of seasonally shed foliage from deciduous streamside trees and shrubs (e.g., *Alnus rubra*, *Sambucus racemosa* var. *racemosa*, *Salix lasiandra* var. *lasiandra*, *Rubus spectabilis*, and *Acer negundo*) in conjunction with exposed rocky debris to influence flow patterns and act as catch-basins for particles in suspension.

17. *Collinsia* spp.—

a) Study what isolating mechanisms, if any, allow two closely related species of *Collinsia*—namely *C. heterophylla* and *C. multicolor*—to co-exist proximal to each other along Swanton and Purdy roads without producing apparent hybrids, even though visited by at least two shared pollinating vectors, both members of the genus *Bombus*.

b) What co-evolutionary factors are in play, causing the *C. heterophylla* populations to be overwhelmingly pale-flowered, while sister species *C. multicolor*, remains basically uniform in coloration throughout its range?

The distributional pattern of the *C. multicolor* populations offers valuable research potential in the study of inter/intra-population gene flow with the following considerations worth investigating:

a) Virtually all flowering *C. multicolor* plants produce viable seed, which when fully mature is dispersed within the current season's population. Over the past 30+ years, I have seen neither loss of vigor nor reduction in population size and wonder if these are inbreeding populations or if there is some gene flow from one or more of the other isolated/localized populations, via the shared pollinating vectors aka the two *Bombus* spp.?

b) Of all the *C. multicolor* populations studied within the watershed and environs, only one has produced any significant color variants—this one down the road from Mountain Lion Gulch, comprising 150+ plants and over the course of 30+ years producing just two alba individuals (with clear cell sap, flowers fading tan without any trace of anthocyanins) and one intensely concolored form.

Are these now-disjunct populations of *C. multicolor* scattered along Swanton Road once part of much larger ones that have been broken up into smaller physically isolated subsets, due to the ongoing slope failures that define much of their current habitat? And do these disruptive events initiate or curtail population expansion?

c) As to the breeding patterns of *C. multicolor*, are they obligate outcrossers, or is selfing also possible? Are all the current populations documented for the Scott Creek Watershed and environs genetically identical, or have some undergone changes on a molecular level that could through continued isolation, lead to the formation of cryptic or micro-species?

d) How do the the local *C. multicolor* populations compare genetically with the remaining viable populations in San Mateo, San Francisco, Monterey, San Luis Obispo, and Santa Barbara counties, some of which grow on serpentine? Are there significant differences, both on a molecular and physiological level?

18. Genetics of long-lived, fire-adapted taxa—Investigate whether long-lived fire-responsive taxa, such as burl-forming members of the genus *Arctostaphylos*, maintain the integrity of their genome, or does each episode of physiological trauma (e.g., fire) give rise to new growth, some/all of which display subtle modifications on a chromosomal level?

19. Rosette-forming plants—Examine the evolutionary values conferred upon both native (e.g., *Taraxia ovata, Sanicula arctopoides*) and introduced (e.g., *Plantago lanceolata, Hypochaeris radicata*) taxa, where emerging foliage forms horizontally aligned rosettes initiated from fleshy, water-retaining rootstocks in a post-fire but pre-rainy season scenario, with an emphasis on the rosette pattern securing valuable surface space from competition, maximizing photosynthesis capabilities, and mitigating sub-surface loss of moisture—and the fleshy taproots having ample dormant buds to offset damage from the effects of fire, plus potential for subsequent herbivory and possessing sufficient stored water to bridge the temporal gap until beginning of Fall rains.

20. *Calamagrostis rubescens*—Compare the net genetic gain/loss from a heterozygous/homozygous perspective, in a long-lived native grass, whose basic mode of reproduction is asexual/vegetative (from extensive clonal colonies growing within mixed conifer/oak woodlands) and typically produces inflorescences only when disturbed by fire, landslides, or through canopy removal (with the corresponding change in the light/temperature regimen).

a) When inflorescences are produced, how successful is seed set and to what extent, with the colonies being principally clonal, is new genetic material being introduced into the existing gene pool?

21. *Quercus parvula* var. *shrevei* x *Q. kelloggii* hybrid—Do a comparative analysis focusing on:

a) ecological (parental association, habitat preferences, and role of disturbance in the broaching of reproductive isolating mechanisms;

b) morphological (bark topography, underlying vascular and epidermal patterns in foliage);

c) physiological (metabolism and growth rate behavior); and

d) molecular (chromosome numbers, mutation rates at specific gene loci, putative gene flow patterns and degree of pollen fertility); and

e) whether selfing, outcrossing and/or backcrossing are possible and historically can partially account for variability within the local *Quercus parvula* var. *shrevei* populations.

Being non-F1 hybrids in reference to the thesis that the local hybrid oaks are the product of ancient hybridization between *Q. kelloggii* and *Q. parvula* var. *shrevei*, with the locally occurring hybrid taxon being the result of two forest live-oaks each carrying the hybrid gene(s) that are necessary (double recessive) for the infrequent occurrence of the scattered/clustered juveniles, which always appear proximal to a *Quercus parvula* var. *shrevei* adult and are wholly removed from any current physical contact with the black oak.

22. *Solanum douglasii*—An in-depth investigation of the variable taxon *S. douglasii* needs to be undertaken, sampling a wide range of habitats from the coastal bluffs up to the chaparral, to determine

a) if all the forms in the watershed and environs are indeed *S. douglasii*; and

b) do those plants with lilac-suffused corollas found on the immediate coast represent past hybridization with the sympatric *S. umbelliferum*, or is the distinctive anthocyanic pigmentation found on stem, foliage, and flowers a physiological response to the stressful, unshaded headland habitat?

23. *Arctostaphylos* spp.—In a post-fire scenario, where weathered (both consolidated and in places fragmented) Santa Cruz Mudstone (e.g., the "Chalks") is the principal substrate and organic material (duff) is minimal at best.

a) What is the viability of the mature fruit (drupes and stones) in the non-burl-forming *A. glutinosa* populations when compared with its burl-forming relative, *A. crustacea* sensu lato, which by occupying the lower ridgetops and interfacing with the oak/conifer woodlands, has accumulated several centimeters of protective leaf litter?

b) When the temporal length between fires exceeds 60+ years and the seasonal deposition of manzanita "fruits" encased within the duff can be profiled vertically, have the "oldest" stones via the action of humic acid been rendered inviable? Are the most recently deposited mature fruits, lacking the insulatory protection afforded by the deeper layers of organic material, destroyed by the "sustained" intensity of the fire, thereby leaving the "middle" layers of stones, giving them the opportunity to germinate in a seedbed of ash-converted duff?

c) Where the duff layer is sparse or absent (as in the "Chalks") and the triggering effects of smoke for germination not or minimally present, can the cracks/fissures in the mudstone act as refugia for replacement seedlings, and are the presence of light, sustained moisture, and mineral soil sufficient to initiate germination and facilitate growth?

24. *Pinus* spp.—Compare sub-populations of *Pinus radiata* (coastal bluffs/headlands) outside of the direct influence of *Pinus attenuata* (via wind-referenced pollen) and the sympatric sub-populations dominating the conifer/oak woodland interface with the chaparral, focusing on

a) bark topography, branch alignment and overall growth structure;

b) leaf morphology, coloration, stomatal distribution;

c) cone structure: color, size, profile/angle of attachment to branch, with particular emphasis on apophysis and umbo gestalt. (The "mucro" points back down towards the base [point of attachment] of the ovulate cones in *P. radiata*, is dominant in the hybrid, miniscule in stature, and after a few seasons reduced to a basal scar thru weathering; while in *P. attenuata*, the mucro is orientated apically, claw-like, long persisting and recessive in the hybrid.); and

d) seed and wing morphology.

e) Postulate the potential role of outlying individuals representing a hybrid population, removed from parental influence through isolation and creating new resegregates via selfing and through time, establishing a highly reticulate pattern of heterozygosity.

f) During the early stages of seasonal growth in seedling/juvenile trees, needles are often 4–5 per fascicle. Is this reflective of a shared ancestry with the 5-needle taxa of Mexico and Central America and represent a currently derived foliar morphology thru reduction?

g) Study and compare the sub-populations of this hybrid swarm–derived taxon growing in the decidedly mesic riparian corridor and often proximal to Scott Creek, with those found "higher and drier" up on the 3rd and 4th terraces as to age/longevity, overall health/disease resistance, through ring counts on dead specimens, rate of growth in dissimilar habitats and reproductive/recruitment success.

25. *Triteleia laxa*—Do a comparative analysis of the two coastal forms to determine if there are two different breeding systems at play, with the regionally widespread Form #1 representing an outbreeding strategy, while the immediate coastal headland Form #2, in response to prevailing wind patterns, has developed an inbreeding, and consequently less variable from a morphological standpoint, reproductive system.

- Form #1—with laterally symmetrical stamens; whitish anthers; and filaments of unequal length; and
- Form #2—with radially symmetrical stamens; blue anthers that turn brown; short, equal filaments; and darker and narrower flowers

26. *Corallorhiza maculata* forma *immaculata*—Examine this taxon from an ecological, morphological, and molecular perspective, to determine whether local forma *immaculata* warrants variety, subspecies, or species status and whether or not it is referable to var. *C. m.* var. *occidentalis*.

27. From a reproductive-isolating mechanism perspective, study the following (often) sympatric pairs of related species found within the watershed and determine if gene flow (uni- or bi-directional) is possible; and if ecologically disruptive events (fire, mass wasting, cyclical flooding) can broach otherwise well-established barriers to gene exchange.

- *Baccharis douglasii*/*B. pilularis*
- *Stachys bullata*/*S. rigida* var. *quercetorum*
- *Eriophyllum confertiflorum* /*E. staechadifolium* (N-end of Swanton Road across from Washout Turn)
- *Epilobium ciliatum*/*E. hallianum* (Beaver Flat Marsh)
- *Trillium chloropetalum* /*T. ovatum*
- *Maianthemum racemosum* / *M. stellatum*
- *Festuca elmeri* / *F. occidentalis*
- *Cryptantha clevelandii*/*C. micromeres*
- *Plagiobothrys bracteatus* /*P. diffusus* (grassy slope margining dirt road between Purdy Road and Seymore Hill)
- *Plantago elongata* / *P. erecta* (original Highway 1 roadbed overlooking Washout Turn)
- *Juncus effusus* var. *pacificus* / *J. hesperius*
- *Isolepis carinata* / *I. cernua* (Old Coast Road weathered mudstone roadbed above Washout Turn)
- *Stipa lepida* /*S. pulchra* (SE-facing bank below Last Chance Road/Swanton Road interface)
- *Nemophila parviflora* var. *parviflora* / *N. pedunculata*
- *Rubus parviflorus* / *R. spectabilis*
- *Erythranthe floribunda* / *E. inodora*
- *Collinsia heterophylla* / *C. multicolor*
- *Acmispon glaber* var. *glaber* / *A. junceus*
- *Sanicula crassicaulis* / *Sanicula* "gianonei", pro. sp. nov.
- *Ribes divaricatum* var. *pubiflorum* / *R. menziesii*
- *Galium californicum* subsp. *californicum* / *G. porrigens* var. *porrigens*
- *Piperia elongata* / *P. transversa* (west-facing hillside overlooking Squirrel Flat/Purdy Road)
- *Claytonia perfoliata* subsp. *perfoliata* / *C. sibirica* (margins of dirt road entering lower/central portion of Little Creek sub-watershed)

28. Asteraceae, subfamily Cichorioideae—A substantial representation of both native (*Agoseris, Hieracium, Malacothrix, Microseris, Rafinesquia, Stebbinsoseris, Stephanomeria,* and *Uropappus*) and introduced (*Crepis, Hedypnois, Hypochaeris, Lactuca, Lapsana, Leontodon, Picris, Sonchus,* and *Taraxacum*) members of this subfamily occur within the Scott Creek Watershed and environs.

a) Do a comparative study/analysis from a structural/engineering perspective of the wind-dispersed (anemochory) cypselae via pappus.

b) Investigate the efficiency of the native versus introduced species-dispersal strategies; and

c) the effect of disturbance (fire, mass wasting, cyclical flooding patterns, agricultural practices) in maximizing these delivery systems/strategies.

d) Map within study area the native versus introduced taxa populations and ecological behavior (persistent versus ephemeral) over time.

29. *Cirsium* spp.—Staying within the Asteraceae but this time the subfamily Carduoideae, focusing on the genus *Cirsium*:

a) Compare the behavior (population demographics and habitat preferences/response to disturbance and competition/genetic variability between populations) of Indian thistle (*C. brevistylum*), Venus thistle (*C. occidentale* var. *venustum*), and brownie thistle (*C. quercetorum*)—all native taxa—with the introduced bull thistle (*C. vulgare*).

30. *Quercus* spp., subgenus *Erythrobalanus*—Do an in-depth study of this group as it progresses up the Schoolhouse Ridge complex from the riparian corridor to the top of the watershed.

a) Where *Q. agrifolia* var. *agrifolia* and *Q. parvula* var. *shrevei* are sympatric, determine whether the foliar variability of both taxa are due, in part, to past hybridization.

b) Determine if there is any reduction in fertility for those trees that show some degree of intermediacy between the parental types.

c) Determine if in those areas where both taxa are growing intermixed, is there any evidence on a molecular level that shows inheritance of hybrid genes, even though from a morphological perspective, traits specific to one parent but not the other (stellate pubescence in abaxial vein-axils, number and alignment of foliar venation) are not apparent?

d) Where *Q. parvula* var. *shrevei* enters the chaparral and undergoes both a reduction in stature and change in foliar morphology, is this still the same taxon exhibiting an ecotypic response to a pronounced xeric environment or a related chaparral live-oak (*Q. wislizeni* var. *frutescens*)?

e) Are there intergrades where these two related taxa meet and if so, is the gene flow uni- or bidirectional?

31. *Pseudognaphalium* spp.—Five native species of *Pseudognaphalium* and one putative natural hybrid (*P. beneolens*, *P. biolettii*, *P. californicum, P.* x "gianonei", pro. sp. nov., *P. ramosissimum*, and *P. stramineum*) reside within the watershed in varying combinations, often sharing the same habitat to the extent that they are growing intermixed:

a) *P.* x "gianonei" (*P. californicum* x *P. stramineum*) being the most obvious (sharing an intermediacy in overall morphology and chemical signature) fertile hybrid combination observed, study this taxon's gene-flow potential (selfing, sib-crossing and backcrossing to either/or both parents), habitat preference/adaptability for colonizing new environments. Is this "new" taxon a successful chance occurrence or where the parental species ranges overlap, sporadic?

b) Since *P. californicum* and *P. ramosissimum* are often found growing together and blooming concurrently, are the occasional plants of *P. californicum* with pinkish-tinged phyllaries the result of hybridization or natural variation within the species?

c) Since the native *Pseudognaphalium* species have distinct chemical signatures besides differences in foliar and floral morphology, do these species-specific "scents" (when warmed by the sun and begin to vaporize) act like pheromones and aid in attracting pollinating vectors and effectively allowing sympatrically related taxa to maintain their genetic integrity?

32. *Cirsium vulgare* (introduced) and *Madia sativa* (native)—Where populations of these grow sympatrically,

a) what role does the glandular/viscid stems and herbage of the tarweed play in trapping (like flypaper) the airborn cypselae of the thistle and concentrating an otherwise wind-dispersed taxon within a localized area, thereby increasing the invasive potential/recruitment for future generations?

b) Study the post-fire ecological impacts of this native/exotic species interaction, where the ash-enhanced growth resulted in both taxa achieving heigths/biomass in the 1.5–2(+) meters range and forming, on *M. sativa*, pappus-cloaked barriers (visually akin to walls of down).

33. *Torreya californica* – Do an in-depth study of *T. californica* found within the watershed (ca. 2000+ individuals of all ages).

a) Map and profile population sizes, habitat preferences, associate species, and age/stature.

b) Document recruitment patterns throughout the watershed.

c) From an evolutionary and ecological perspective, analyze the post-2009 Lockheed and historical (if possible) fire responses and subsequent regenerative capabilities.

d) Since this taxon is exceedingly long-lived and can perpetuate itself both sexually and asexually, map the genetic diversity within and between populations, clarifying what proportion is clonal versus seed-derived in origin.

e) Study the number of male to female adults in any given area and see what ratio is needed to establish successful fruit set.

f) Do the resinous components found in the aril enclosing the seed change from protective (when seed is developing) to palatable (when seed is mature and ready for dispersal), and are the clues cueing in the dispersing vector(s), visual (color change) and/or olfactory?

g) Does the aril protect the seed from dessication until suitable germinating conditions occur? Does the aril have to be ruptured first to allow the mature seed to imbibe the necessary water to initiate germination, and is darkness or light needed to initiate germination?

h) Since the majority of seedlings and immature adults are found growing as understory constituents under shaded or dappled light conditions, is the reduction of aerial stature offset by the establishment of an extensive root system, which when a break in the canopy cover by storm damage or the senescence of adjacent trees occurs, allows the "waiting-in-the-wings" young adults to quickly take advantage of the change in light regime and "bolt"?

34. Distribution patterns and ecological constraints:

a) Why does *Festuca subuliflora* follow *Sequoia sempervirens* downstream of the Scott Creek Bridge (albeit sporadically), while associate species farther upstream (*Clintonia andrewsiana, Scoliopus bigelovii, Boykinia occidentalis, Tiarella trifoliata* var. *unifoliata*, *Hierochloe occidentalis, Anthoxanthum occidentale, Viola ocellata*, *Viola sempervirens, Whipplea modesta*, and *Blechnum spicant*) have not expanded their ranges downstream, even though in varying combinations, this native species combo also occurs in the other sub-watersheds feeding into Scott Creek proper?

b) Going from the moist and semi-shaded riparian corridor to the decidedly xeric chaparral and coastal scrub, what ecological preferences confine *Pellaea mucronata* var. *mucronata* to the upper reaches of the watershed (principally the "Chalks"), while sister species *P. andromedifolia* extends its range all the way down to the coastal headlands?

35. Using GIS, LIDAR, and other related mapping tools, see if there is a correlation between topography, geomorphology, and biodiversity, using the following areas within the Scotts Creek Watershed and the in situ documentation for those areas found within the essay "Traversing Swanton Road."

Area #1: Schoolhouse Ridge complex, between Scott and Mill creeks, extending from Swanton Road up to the "Chalks."

Area #2: Old Schoolhouse Road, between Little and Winters creek drainages, from Swanton Road to top of ridge/Cemex property boundary.

Area #3: Laird Gulch complex, from Last Chance Road down to entrance into Scott Creek.

Area #4: Magic Triangle Ridge/Synform drainage complex and the attendant 7+ "gulchlets," which coalesce into one narrow stem that enters Scott Creek just below the Scott Creek Bridge.

Area #5: the east-northeast-oriented drainage system, beginning near the Mt. Cook area and entering into Scott Creek, between the confluences of Big and Little creeks also contains isolated chaparral disjunct, worthy of a study unto itself!

Area #6: the complex series of landslide-derived, hydrologically active, benched spring-fed marshes, beginning with "Beaver Flat" and stepwise, descending southward down to the "Marti's Park Marsh."

Area #7: the west-facing, descending grassland/chaparral mosaic beginning at the top of the Seymore Hill and flanked by Calf Gulch to the south and Bettencourt Gulch on the northwest, including the "bowl area" and basally demarcated by Purdy Road and areas #8 and #9.

Area #9: the bifurcate drainage system, which includes Cookhouse Gulch as one contributor and the adjacent (southeast-flanking) benched, incised, and possibly rotated gulch complex, home to two uncommon native grass species *Elymus californicus* and *Festuca subuliflora*.

36. *Lupinus formosus* var. *formosus*—Study the isolated populations of this locally rare taxon.

a) Note the extreme variability in seed-coat patterning within a given population. Is this the result, from an evolutionary perspective, of generating multiple series of seed coats varying in their surface coloration, allowing some seeds to blend into the surrounding dry grasses, exposed rocky debris, etc.—and by crypsis (camouflage) offsetting predation for at least some of the season's mature seeds?

b) Compare recruitment success between more or less uniformly patterned *L. arboreus* seeds with those of the sympatric *L. formosus.*

c) Determine if populations of *L. formosus*, both locally and elsewhere, succeed best in grasslands where the textural variability of the surrounding vegetation can be correlated with seasonal rainfall and consequent changes in frequency/timing from year to year.

37. *Sequoia sempervirens*—Using the two visually distinctive Laird Gulch populations as a baseline, do an in-depth study comparing the riparian corridor and chaparral populations of *S. sempervirens* to determine

a) if there are genetic differences between the two ecotypes; and

b) if so, are there physiological and metabolic differences correlative to their mesic versus xeric habitats?

c) Are the differences in stature and foliar pigmentation genetically fixed and transmittable via seed?

d) Are there temporal differences in achieving reproductive maturity and are there any measurable deviations in ovulate cone size, quantity and size of seed produced and fertility, both as to pollen and seed?

e) Using chloroplast DNA and other genetic markers (as per differences in mutation rates), is there any correlation from a geomorphological perspective between uplift and downcutting through erosive action, which theoretically over time could have separated what originally was one population into two?

f) Do a comparative study with the chaparral ecotype growing on the "Chalks," between Bettencourt Gulch and the Seymore Hill.

38. Fruit characteristics and seed dispersal strategies — Along Swanton Road, between Scott and Big Creek bridges, several native taxa can be observed during the Fall season, producing ripe fruit, which in varying degrees, is both fleshy (baccate) and/or in the red-to-orange color range. Approaching this subject from a co-evolutionary viewpoint:

a) Is fruit color falling within the red to orange end of the spectrum vector-specific relating to dispersal?

b) Can color and the ability of the epidermal surface of the ripe fruit to refract or reflect light act both as an enticement and/or a warning? *Lonicera hispidula* with intensely colored but not lustrous fruits, versus *Actaea rubra* with nitid as if varnished fruits, which contain the glycoside ranunculin?

c) If the co-evolutionary value of color-coded/vector-dispersed fruits is the establishing of new populations that are not competitive with the seed-producing parent and thereby insuring outbreeding and the potential for increased genetic diversity, how successful within the Scott Creek Watershed is this strategy, particularly when several of the taxa involved are also long lived and expand their biomass, asexually, through rhizomes?

d) Along this relatively short section of Swanton Road, are several other plant species with fruting bodies possessing varying degress of succulence and coloration. Can a pattern of coevolution be established, based on fruit color and secondarily, odor, for these taxa, and are the dispersal vectors species specific or generalist in nature?

- *Prosartes hookeri* — With pendant, semi-glossy, oblate-spheroid, reddish-orange fruits looking like reduced-in-scale cherry tomatoes, *P. hookeri* presents an interesting contradiction. The habitat for this monocot is usually the mixed conifer/hardwood semi-shaded understory, and the ripe fruits as well as the greenish-white flowers are pendant and for the most part, hidden from aerial viewing. Even though the over-arching foliage of this species is deciduous, what role does color play in fruit dispersal when it is so cryptically displayed, and is there an olfactory component involved?

- *Euonymus occidentalis* var. *occidentalis* — Also possessing pendant flowers and fruits but this time suspended by hair-thin peduncles and having the exposed seed enclosed in a reddish-orange aril, the seasonally deciduous 2–4 meters in height shrub, presents yet another question of fruit/seed dispersal.

- *Rubus parviflorus* and *R. spectabilis* — Two related and often sympatric-growing species with fruits an aggregate of orange/red/pink-colored drupelets margin both the roadside and adjacent streambanks.

- *Rosa californica* — With fleshy reddish-orange "hips" aka ripened flower-tubes, this species was observed 10/29/10 growing with both hairy honeysuckle and blue elderberry, their fleshy fruits a study in contrasting colors.

- *Heteromeles arbutifolia*—Staying within the Rosaceae, with scarlet pomes on terminal corymbose panicles, this shrub offers birdlife nourishment during the bleakest time of the year.

- *Maianthemum racemosum* and *M. stellatum* – Both sport succulent berries colored reddish-orange through reddish-purple, accenting the wooded slopes overlooking the riparian corridor.

- *Arbutus menziesii*—Gives the toyon competition, with an the end-of-season display of panicles laden with berries the color of blood oranges.

- *Sambucus racemosa* var. *racemosa*—Still staying within the warm end of the visible light spectrum, the cymose panicles of the red elderberry present a visual feast for end-of-season avians, and is this a generalist banquet or are certain bird species targeted?

Seed-dispersal strategies—Here is a partial listing, which ultimately could be extended to cover the entire watershed, of native taxa to study for their seed-dispersal strategies and to what extent coevolution is a key component.

- *Galium californicum* subsp. *californicum*—Fruit baccate and translucent.
- *Frangula californica* subsp. *californica*—Fruit a drupe and dark purplish-brown.
- *Sambucus nigra* subsp. *caerulea*—Fruit a drupe, blackish coated with a glaucous bloom.
- *Ribes menziesii*—Fruit a berry, purplish densely covered with stiff hairs some of which are gland-tipped.
- *Cornus sericea* subsp. *sericea*—Fruit a drupe, greenish suffused with purple turning milky-white at maturity.
- *Oemleria cerasiformis*—Fruit a drupe, blue-glaucous.
- *Rubus ursinus*—Fruit an aggregate of blackish-purple druplets
- *Solanum douglasii* – Fruit a black berry.
- *Solanum umbelliferum* – Fruits colored an off-white with basal portion greenish.

39. Fungal pathogens—Does a coating of dust (mudstone, in part, reduced to powder) on the adaxial foliar surface of *Agrostis hallii* and related species, act as a barrier, to the establishment/ development of fungal pathogens (e.g., rusts) during the summer months, as observed along the upper section of dirt road that enters into and parallels Little Creek?

Study the various taxa within a given area, where the fungal pathogens are known to occur, and analyze, from a foliar topography perspective, which conditions have to be met in order for the fungal spores to become attached and subsequently germinate.

a) Are foliar surfaces with recessed stomatal pits, impressed veinal patterns, and various trichome modifications, more susceptible than leaves with stomata only on the abaxial surface, adaxial surfaces which are plane and/or coated with a waxy bloom or thickened cuticle?

b) What role does exposure to the elements (sunlight, wind, and moisture-laden riparian air movement patterns) as opposed to tree trunk/canopy-induced shade and the concomitant light reduction/air flow restriction, play in conjunction with the aforementioned physical conditions defining the foliar surfaces?

40. *Fritillaria affinis*—Study the local populations of *F. affinis* from both an ecological and molecular angle.

a) Are the immediate coastal bluff populations, with their larger-in-size, thicker-in-texture, and darker-in-coloration flowers, distinct from the watershed/riparian corridor populations, both as to genetic makeup and pollinating vector/reproductive behavior?

b) Are the "intermediate phases" (found where the Western Terrace is bisected by the lower section of Big Willow Gulch) a subspecies in the making (with the gene-flow isolation being complete in the coastal bluff population(s)?

c) Can one make a determination, based on morphological and molecular studies, of the transition from an outbreeding series of overlapping populations within the Scott Creek Watershed proper (forma typica) through the distinctive/isolated coastal bluff taxon and what is its relationship with the analogous North Coast subspecies *tristulis*?

41. Do a botanical distributional analysis of the Scott Creek Watershed and its environs, showing familial representation broken down by genera and species (e.g., APIACEAE, *Sanicula, Sanicula hoffmannii*) and

a) using this relatively small (30 square miles) but species-rich (10–12%+ of California's flora) coastal watershed as a baseline, do a comparative profile of the watersheds to the north and south.

b) Within the Scott Creek Watershed, is there any correlation between species distribution and habitat specificity?

c) Examine the human footprint within the watershed where there is a known timeline (e.g., coastal prairie/Western Terrace) and determine what is the ratio of native to introduced taxa and can any trends be observed, such as:

1) Native taxa peripheral to areas formerly under cultivation recolonizing the fallow fields.

2) Other native taxa being marginalized/isolated by newly introduced and more aggressive species.

3) Sympatric, related taxa that may or may not be genetically compatible (e.g., *Agrostis, Carex*), having their reproductive isolating mechanisms broached by the disturbance regimes (punctuated equilibrium) and new "hybrids" or genetically "enriched" species emerging.

42. *Juncus* spp. — Analyze from morphological, molecular, reproductive, ecological and biogeographical frames of reference, the distinctive open-paniculate "form" of *J. occidentalis*, which occurs in Beaver Flat and has been observed in situ for the past 30+ years, as well as documented by herbarium pressings (UC Berkeley/Jepson Herbarium) and is represented by living material and seeds at the UCSC Arboretum.

a) Since the forma typica for *J. occidentalis*, in Beaver Flat and the rest of the Scott Creek Watershed, has a loose to densely capitate inflorescence, is the open-paniculate "form" (simulating the sympatric *J. bufonius*) an extreme variation of the type or is it indicative of a shared lineage with *Juncus tenuis*?

b) What accounts for the persistent/localized occurrence of the open-paniculate "form" in Beaver Flat but not elsewhere in the watershed? Could this be due to isolation/inbreeding of a population referencing *Juncus tenuis* genes?

c) Is the open-paniculate "form" reproductively isolated from the sympatric forma typica of *J. occidentalis* and if selfed or sib-crossed, would the F1 offspring be uniformly the open-paniculate "form" or reflect the overall Beaver Flat population in the ratio of plants with open-paniculate to closed (capitate) infloresences?

d) Is there an efficiency differential, in terms of successful pollination/fertilization, between the open-paniculate and congested (capitate) inflorescence plants?

e) Paralleling the open versus densely congested inflorescence dimorphy of *J. occidentalis* is another Juncaceae member and Scott Creek Watershed botanical component, *Luzula comosa* var. *comosa*. Do a study to ascertain if the underlying mechanisms determining both taxa's inflorescences are shared or independently derived from different environmental pressures.

43. *Claytonia perfoliata* subsp. *perfoliata*—Numerous self-perpetuating micro-populations are present throughout the watershed, which when growing sympatrically still maintain their distinctive calyx coloring/patterning:

a) Study the reproductive isolating mechanisms (obligate selfer versus outbreeder).

b) Study the gene/genes controlling pedicel, calyx, and corolla pigmentation (one or multiple, recessive/dominant).

c) Study what, if any, pollinating vectors are involved.

d) Categorize the various color patterns as to 1) frequency of occurrence; 2) variability within a given population; 3) habitat correlation with specific pattern; 4) heterozygous or homozygous for color/pattern when artificially selfed; and 5) when artificially crossed, do these variants act as microspecies?

44. *Erythranthe guttata* complex—With several components of the *E. guttata* complex (*Erythranthe* sect. *Simiola*) represented within the Scott Creek Watershed and environs, initiate a study that includes field observation, controlled garden studies, and laboratory analysis to determine:

a) The role of pollinating vectors in maintaining genetic integrity of sympatric, related taxa.

b) The importance of corolla morphology, lip patterning, and scent in attraction/facilitation of potential pollinating vectors.

c) The genetic versus environmental basis for annual/perennial growth patterns, and the related hydrological implications of cleistogamous/out-breeding reproductive systems.

d) Are there structural/morphological differences within the various subsets of the *E. guttata* complex—such as seed gestalt—that are consistent enough to warrant form, varietal, or species status?

e) Study the relationship between the nanistic, self-pollinating taxa found growing on moss-covered mudstone (upper Calf Gulch and coastal gulches abutting Highway 1) and the often robust forms of *E. nasuta* growing on sandbars within the Scott Creek riparian corridor.

f) Do controlled artificial breeding studies with the various members of the *E. guttata* complex locally, to determine intra-specific compatibility, uni-directional versus bi-directional gene flow, foreign pollen inducing facultative apomixis; and if sufficient moisture is present, can cleistogamy be replaced temporarily with a modified out-breeding system?

45. *Carex* hybrids—With more than 150 examples of *Carex* x "imperfecta" documented for the coastal prairie, between Lasher and Scott Creek marshes, investigate this putative hybrid link between the Multiflorae and Ovales sections from the following angles:

a) Pollen production and fertility. Do all or only some "imperfectas" produce pollen and does fertility vary from plant to plant?

b) Formulate scenarios for origin of the "imperfectas." Are all the *Carex* x "imperfectas" F1 crosses or the result of selfings and/or backcrossings of the fertile *Carex* x "nitidicarpa" (*densa* x *subbracteata*) onto either parent?

c) Longevity and fertility. Does fertility change through time, and does age of plant and amount of accrued biomass have any influence?

d) Vertical versus horizontal (erect-ascending/prostrate) alignment of flowering culms. Potential differences in wind-born-pollination efficiency.

e) Solitary versus clustered distribution of "imperfectas" and potential for maximizing unidirectional "hybrid" gene flow back into sympatric parental gene pool.

f) Study the role of natural/manmade disturbance patterns and the broaching of reproductive isolating mechanisms in both the formation of primary and complex crosses and the role non-Mendelian genetics (gene fragments from centromeric fission/fusion) play in the *Carex* "gianonei/imperfecta/nitidicarpa" syngameon.

g) Map the occurrences of *Carex* x "imperfecta," with regard to both previous land-use activity and presence/absence of either or both parental species.

h) Chart the transformation of *C. subbracteata* to *C.* x "nitidicarpa" by examining thickness, angularity, marginal scabridity, and resistance to tearing of mature flowering culms (influence of *C. densa)*, presence of compound-congested lower 1–5(+) spikelets (reduced panicle branches derived from *C. densa*), changes in arrangement of staminate and pistillate flowers (gynaecandrous/androgynous/mixed), and overall morphological variability plus intra-populational fertility.

i) Are the *C.* "gianonei" (*C. harfordii* matrix) populations older in origin than the local *C.* x "imperfecta"/*C.* x "nitidicarpa" representatives? Chart the distribution patterns for both, within and outside of the Scott Creek Watershed, to determine if the (non-functioning pistillate) *C.* x "imperfecta" and (fertile) *C.* x "nitidicarpa" can occur in the absence of either/both *C. densa* and *C. subbracteata*.

j) Do a comparative analysis between the coastal prairie and interior (Beaver Flat, West's Spring Marsh, Marti's Park Marsh, Laguna de las Trancas drainage) occurrences of *C.* "imperfecta" and catalog the similarities/differences from both a structural and ecological perspective (at least two distinct forms of *C.* x "imperfecta" occur on a consistent basis, with Form #1 stramineous/shiny in coloration, often with an elongate rachis displaying 4 or more compound-congested spikelets and on rare occasions with perigynial scales apically awned, while Form #2 can have inflorescences with either simple or compound-congested spikelets, are dark brown/dull in coloration, and the overall gestalt is often stiff/rigid or elongate and flexuous.

k) Where populations of both *C. densa* and *C. subbracteata* occur sympatrically, does the direction of gene flow between the two species determine whether the hybrid offspring become *C.* x "nitidicarpa" or *C.* x "imperfecta"?

46. *Juncus hesperius* x *Juncus patens* hybrids: As with the *C.* "imperfecta" hybrids, the *J. hesperius* x *J. patens* hybrids can possibly offer valuable insights into evolutionary theory and speciation, with some of the following issues needing to be addressed:

a) Determine if the hybrid is self-fertile and if so, how does this play in the hybrid genes potentially referencing back into either parental species?

b) With very low to non-existent viable seeds often being produced, is pollen fertility equally low or possibly higher, which could offset the poor seed production?

c) With parents having 3 (*J. hesperius*) and 6 (*J. patens*) stamens respectively, is the fertility of the hybrids variable on an individual stamen level?

d) Does longevity and increase in biomass bring about changes in the hybrid's fertility, or is this an immutable condition?

e) With both parents displaying "natural" variability as to overall gestalt (*J. hesperius*, in particular, as well as higher fertile seed count), could some of this morphological plasticity be due to backcrossing with the hybrid offspring?

f) What is the trigger mechanism that allows the hybrids to occur—natural or anthropogenic disturbance? Is the gene flow uni- or bi-directional between the parents?

g) Do the F2 offspring, if they occur "naturally," display heterosis (hybrid vigor), or are they inherently weaker and prone to shorter life spans and total sterility?

h) Is the mucilaginous encasement that uniquely defines the mature/opened capsules of *J. patens*, when exposed to moisture, a recessive trait or does it carry on into the F1 and higher hybrid generations?

48. *Juncus patens*—Expanding on and relevant to the aforementioned discussion of *J. hesperius* x *J. patens* hybrids, is the following post-anthesis behavior of *J. patens,* unlike the other 10 species of *Juncus* (*J. acuminatus*, *J. breweri*, *J. bufonius*, *J. effusus* var. *pacificus*, *J. hesperius*, *J. mexicanus*, *J. lescurii*, *J. occidentalis, J. phaeocephalus*, and *J. xiphioides*) occupying the watershed and its environs, the mature/opened capsules of *J. patens* when exposed to moisture, envelop the seeds in a gelatinous encasement analogous to a cluster of microscopic frog eggs. This distinctive characteristic is not made mention of in the principal literature dealing with California floristics (Abrams, Hoover, Howell, old and new Jepson, Mason, Munz and Keck, or older floras dealing with the section Genuini, such as Britton and Brown, the recent *Flora of North America* or family overviews, Heywood).

a) Is the gelatinous material derived from the seed coat or the interior wall of the capsule?

b) From a co-evolutionary perspective, does it facilitate seed dispersal, either as an adhesive or when dry, and/or act as a visual attractant to disperse the concentrated seeds in easily fractured glassine packets?

c) What is the chemical makeup of the mucilaginous secretion that the seeds are embedded in? Does it act as a fungicide and/or have pathogen-inhibiting properties?

Note: On 12/11/2012, while studying the *Juncus* populations growing along the north end of Swanton Road, I came across a *J. patens* with mature opened capsules not only encased in a mucilaginous "bubble," but on several inflorescences some of the embedded seeds were germinating, with the seedlings averaging 3–4 mm in length! The weight of the globular mass, specifically with those culms that are unsupported, bends them downward and in this particular case they were resting on the ground.

d) Does the gelatinous encasement of the seeds act as an alternate substrate, analogous to the agar-agar used in the germination of orchid seeds, and are there two germination strategies at work? If the ripening of the capsules coincides with the rainy season, then instant recruitment while the seeds in those capsules are maturing without seasonal hydration may enter a state of dormancy, fall to the ground, and remain viable but inactive for an unknown period of time.

48. *Chlorogalum pomeridianum* vars.—In some ways paralleling the *Monardella villosa* subspecies (*villosa* and *franciscana*), the two varieties of *C. pomeridianum* locally (*pomeridianum* and *divaricatum*) present opportunities to study the underlying mechanics of intraspecific variation within a biogeographically defined environment. Some questions to be asking are as follows:

a) Is habitat preference, exposed edges of grassland-covered terraces versus sheltered understory of mixed hardwood/coniferous woodland, in part genetically determined? How adaptable would seedlings of both varieties be, when raised ex situ, then transplanted to their varietal counterpart's habitat?

b) Are both varieties outbreeders, and does the vespertine blooming time aid the exposed var. *divaricatum* with a respite from the often daily westerly wind patterns?

c) With the inflorescences reduced in stature and branching patterns often at right angles to the main axis in var. *divaricatum*, do other vectors besides moths play a role in pollination?

d) Are there measurable physiological and metabolical differences between the two varieties, considering the differing ecological conditions that both are exposed to—such as:

1) bulb size , shape, and storage capacity;

2) seed size, numbers produced, and differences in their nutritional reserves, recruitment success, and growth rate/maturation times between the two varieties under controlled conditions?

3) Are there any differences on a chromosomal level between the two varieties that would prevent successful fertilization and the establishment of intraspecific hybrids, should populations of var. *pomeridianum* and var. *divaricatum* overlap? And relevant to this question, have the two varieties in question been isolated long enough from each other to have any genetically set differences that would preclude the successful exchange of genetic material?

49. *Bromus carinatus* complex—Do an in-depth study of the *B. carinatus* complex found within the Scott Creek Watershed and environs.

a) Determine which populations are obligate selfers and which are outbreeders through anemophily (wind pollination) and how these reproductive strategies relate to each population's overall gross morphology and genetic variability.

b) Does the continued presence of atmospheric moisture (fog or nocturnal condensation) such as that found in habitats with a close proximity to the ocean play a co-evolutionary role in the development of a closed breeding system?

c) Several distinctive "forms" of *B. carinatus* repeatedly occur throughout the Swanton area, one of which warrants closer examination. What separates this component of the *B. carinatus* complex from the numerous other local variants?

d) In light of the following characters: 1) height: 1.5–2 meters; 2) leaf width 2.5 cm or more, often shallowly plicate; and 3) inflorescences large and intricately branched with lower branches conspicuously retrose in alignment, do these observable "morphologies" have corresponding underpinnings on a molecular level, which when coupled with the frequency of occurrence, could lead to the taxon being given varietal status?

e) On the Santa Cruz and Western Terraces, between Waddell and Scott Creek beaches, another distinctive phase of *B. carinatus* occurs, showing affinity to (and is possibly conspecific with) *B. maritimus*. The distinguishing attributes of this native brome being that the lowest glume is 3-veined, and the second glume has 5–7 veins with the branches of the inflorescence appressed-ascending to arcuate, equal to or shorter than the spikelets, and at maturity becoming prostrate or nearly so.

f) Several *B. carinatus* populations within the Scott Creek Watershed exhibit a consistant and distinctive trait of having the lowermost branches of the inflorescence conspicuously elongate/pendant with the spikelets concentrated apically. Is this a reflection of ancient hybridization with *B. sitchensis* and could a DNA analysis validate this hypothesis?

50. *Toxicodendron diversilobum*—Poison-oak has two basic growth patterns within the watershed: a free-standing, low-growing to sub-arboreal shrub and a tree-supported woody vine, which can exceed 20 m in height and have a stem diameter, six feet above ground level, exceeding 13 cm.

a) Do the free-standing and tree-supported forms exhibit physiological, metabolic, and structural (cambium-layer production, vascular transport systems) differences based on the contrasting distances between root systems and photosynthesizing foliage?

b) Is there a dropoff in successful pollination/fertilization and corresponding fruit set, when the liana-like form reaches a specific heigth threshold, and the vector-attracting floral scent is more apt to be impacted by air movement, temperature and density of host-tree canopy?

c) Can any poison-oak seedling, given the opportunity, develop one or the other growth patterns, or is this behavior genetically determined and environmentally reinforced?

d) With long-established vines observed growing on *Aesculus, Pinus, Pseudotsuga, Quercus, Sequoia, Torreya,* and *Umbellularia* species, are there specific requirements, such as bark topography, durability, and moisture retentiveness that have to be met before the attachment process begins?

e) Are there differences in the root systems and food-storage capacities of the two growth forms? Have the ligneous aerial stems of the support-dependent variant developed supplemental storage zones due to the greater vertical differences between roots and foliage?

f) With some of the largest—both in terms of stem diameter and height reached—examples of the vine form found growing on the long-lived *Sequoia sempervirens*, is there a life-span difference between the two growth forms or does longevity reside within the root system's regenerative capacity?

g) Do the woody stems of the vine form act like vertical rhizomes, attaching themselves to the bark with modified root systems, and is any part of the exposed surface of the attached stems capable of photosynthesis?

h) Is there a difference in rate of growth, at least initially, between the free-standing and supported individuals, with the reflected light and radiant heat through convection from the bark of the arboreal support, being potential factors?

51. *Polypodium calirhiza*—As a bonafide temperate epiphyte, *P. calirhiza* is found throughout the watershed on a variety of arboreal hosts, in some cases forming extensive, long-established colonies while in other situations poorly represented by a barely surviving remnant.

a) With both evergreen (*Pinus radiata, Pseudotsuga menziesii* var. *menziesii*, *Quercus agrifolia* var. *agrifolia, Quercus parvula* var. *shrevei, Sequoia sempervirens*, *Torreya californica*, *Umbellularia californica*) and deciduous (*Acer macrophyllum, Acer negundo*, *Aesculus californica*, *Alnus rubra*, *Sambucus nigra* subsp. *caerulea, Salix lasiolepis*) trees observed serving, in varying degrees, as aerial habitats, is one factor for successful colonization the bark's capacity to sustain healthy bryophyte populations, with their hygroscopic nature and potential for creating "nurseries" for the wind-borne spores to develope into gametophytes?

b) Inventory the arboreal and sub-arboreal taxa found in and around the Scott Creek Watershed, categorizing the various "host" species as to suitability for *Polypodium* colonization, ranging from optimal through inhospitable. (In one notable instance, a dead, very old, and massive hybrid pine (*Pinus radiata* complex) along Swanton Road had some 40+ feet above ground level developed on the horizontally aligned upper branches "moss pads" hosting *P. calirhiza* colonies.)

c) What other conditions have to be met for sucessful colonization, even if the tree's bark topography has existing "moss pads," and can trees with seasonally exfoliating bark such as *Arbutus menziesii*, due to the structural integrity of its wood, become "hosts" after-the-fact when the subject in question dies but continues to exist for an indefinite period of time?

d) Of all the tree species studied to date with persisting colonies, the most successful as to longevity of occupancy and areas on the tree's surface, both vertically and horizontally, has been *Umbellularia californica*. What characteristics—be they bark structure, biochemical makeup, branching patterns and canopy configuration, ecological preferences, proximity to riparian corridor, etc.—allow this particular taxon to consistently, when colonized, be a more effective host?

e) With *P. calirhiza* being an allotetraploid derived via hybridization from *P. californicum* and *P. glycyrrhiza*—and its ecological preferences ranging from terrestrial through epiphytic—are all the arboreal colonizers in the Scott Creek Watershed *P. calirhiza*? Or could some of the populations be comprised of both *P. calirhiza* and *P. glycyrrhiza* and possibly *P. californicum*, even through the latter is not considered an epiphyte?

f) Since the *P. calirhiza* populations growing on *Umbellularia californica* often reach heights of 25+ m, does this confer an advantage in the distribution of spores via air movement to adjacent trees or, at this elevation, do the air-flow patterns have a desiccating effect, resulting in the higher reach "moss pads" drying out and being less conducive for the spores to develop into the gametophyte generation?

g) Can one ascertain the age of a given colony from the branching patterns and lengths of the rhizomes?

h) What is the genetic make-up of long-established plants covering a substanial portion of a given host?

i) Are all the scattered "micro-colonies" a) clonally derived; b) the by-products of the original "colonizer" being selfed; and/or c) a combination of selfings and out-breeding between the various "micro-colonies"?

j) With wind being the primary spore-delivery vector, can any pattern of genetic change between these "micro-colonies" be correlated with their distribution along a vertical/horizontal axis of the host tree's bark topography?

52. Local woodlands often consist of a dozen or more arboreal and sub-arboreal native taxa with varying growth patterns and foliar configurations. Initiate a study on the inter-relationships between multi-layered canopy

complexity, sunlight distribution patterns, and understory biodiversity. Within this comprehensive overview, examine the following conditions:

a) Slope orientation, degree of inclination, evidence of recent and/or prehistoric mass wasting.

b) Comparing height, trunk alignment, branching patterns, and bark topography (surface conductivity/absorbency of rainfall/fog condensation) characterizing the arboreal components of the woodland being studied.

c) Examine the variations in foliage, whether deciduous or persisting for several seasons 1) fasciculate (*Pinus*) or solitary in arrangement/attachment; 2) adaxial-surface modifications such as impressed/elevated veins; 3) and varying types of trichomes creating a waxy bloom or a glossy and reflective surface like a mirror (*Arbutus menziesii*), thus redirecting sunlight back up into the upper canopy levels.

d) Study the foliar chemistry (phenolics, nitrogenous compounds, terpenes) and the corresponding behavior of the species-specific leaf litter as to breakdown rate, pH influence of current leaf drop and the buffering influences of previous litter accumulation, microbial/fungal interaction, inhibition of seed germination (allelopathy), and concentration/displacement of rainfall-derived water and leaching out/subsurface transport of the chemical constituents of the freshly shed foliage.

e) Study the air-movement patterns within the above-described woodlands and the impact they have seasonally as to pollen distribution (*Pinus*, *Pseudotsuga*, *Sequoia*) and evaporative loss both within the multilevel canopy and ground-cover constituents, accelerating the shedding of arboreal foliage and moving/mixing of differing leaf-litter types away from their primary sources.

f) Within the mixed conifer/oak woodland sensu lato, are there ecological subsets based on species-specific taxa with their distinctive foliar characteristics (e.g., *Sequoia sempervirens*, *Pinus radiata*, *Quercus agrifolia* var. *agrifolia*) that create zones hosting differing suites of understory species as well as sharing certain native vegetative components?

f) When a mature aboreal specimen (e.g., *Umbellularia californica*, *Pinus radiata*, *Quercus parvula* var. *shrevei*)—with an extensive biomass (crown/trunk) and horizontal subsurface root system—topples within this complex woodland ecosystem from either age/disease-related or storm-induced causes, does this disturbance regime have a cascading/rippling effect on the surrounding woodland due to change in sunlight-distribution patterns, air-movement corridors and disruption of the understory's O, A, and B soil horizons, to cite just three separate but related events? How does this singular event impact/alter the woodland's biodiversity?

53. Disjunct populations—Several native taxa occur within the Scott Creek Watershed and its environs that are disjuncts relative to the area of their typification: *Agrostis blasdalei, Amelanchier utahensis, Arctostaphylos crustacea* subsp. *subcordata, Clarkia* aff. *prostrata, Clarkia purpurea* subsp. *purpurea, Hippuris vulgaris, Prunus emarginata, Quercus parvula* var. *shrevei* x *Q. kelloggii*, *Nemophila* aff. *pulchella* var. *fremontii,* and *Sanicula hoffmannii*.

a) Do a genetic profiling of the local representatives of these "displaced" taxa, comparing them, where possible, with representatives from the type localities and seeing if geographical isolation has produced any changes on a molecular level.

b) From an ecological perspective, what are the similarities/differences in habitat preferences, if any, between the species occurring in the "type" site and the Swanton-area populations?

c) Are there any differences in pollination vectors between the "type" population and the "extended range" colonies found locally?

d) In the case of long-lived rhizomatous taxa, is colonial expansion solely sexual via seed dispersal or/and clonal?

e) Where closely related sympatric taxa occur, either at the originally described population's locality or the one(s) documented for the Scott Creek Watershed, is there any evidence validating the exchange of genetic material?

f) Within the local watershed and its environs, are the "disjuncts" in question expanding their range, holding their own, or is their foothold within the area shrinking?

54. *Dudleya caespitosa*—Within the area covered by this essay, polyploid *D. caespitosa* ranges from the ocean edge of the Santa Cruz Terrace up to the "Chalks," which separate the Scott and Mill Creek drainages. The isolated inland populations are usually localized/relictual as to habitat and considerably more homogeneous as to rosette/leaf gestalt, with corollas often paler in coloration, thinner in texture, and more elongate than the polymorphic coastal headland populations with their intensely colored, shorter in stature, and thicker in texture corollas.

a) Map the various populations as they range elevationally, from the coastal bluffs (ca. 70 ft. el.) up to the "Chalks" (ca. 700 ft. el.) and see if there are changes in ploidy levels as one progresses farther inland.

The highest numbers being on the immediate coast (where populations exhibit an extreme degree of foliar/rosette plasticity and are ecologically versatile, readily establishing themselves on both the horizontal grass/coastal scrub–dominated terrace tops and near-vertical cliff faces, the latter including seasonally wet waterfalls) and the lowest numbers belonging to the inland "isolates," which possibly represent earlier evolutionary stages of this species complex and being physically removed (out of pollination range) from the exchange of genetic material with the dynamic and still-evolving coastal populations, are literally trapped in time!

b) Analyze the corolla pigments and see if there are differences between the interior and coastal headland populations and if any correlation can be made between ploidy levels, floral pigments, and overall corolla structuring, including presence/absence of multi-branched inflorescences and pedicel lengths.

c) Compare the various "isolate" populations (Schoolhouse Ridge, "Chalks," upper Little Creek) with each other and where clines, albeit fragmented ones, occur (Schoolhouse Ridge). Is there an overarching uniformity, or do each of these "micro" populations represent a stabilized variant of the original genome?

d) Examine length of corolla and whether the diameter remains constant or narrows towards the apex, and how this along with coloration delimits the potential pollinating vectors, even between two different members of the Hymenoptera, e.g. *Apis mellifera* and *Bombus* sp.

e) Has corolla shape (the apex diameter in particular and pigmentation—greenish-yellow through red) been an important mechanism in the speciation of the genus, with hummingbirds and various hymenoptera as the co-evolutionary agents?

f) Are *Dudleya* spp. self-fertile, or are they obligate out-breeders? How does this translate out in the uniformity of some populations and the variability as to rosette patterns and inflorescence complexity of other populations?

Note: Prior to the 1981–82 El Niño storm impacts on the Scott Creek Watershed, an isolated population of the *D. caespitosa* complex existed above the lower Big Creek Falls, growing streamside on the moss-covered granitics. If it still exists, a molecular work-up of this definitely isolated taxon may yield some valuable data as to this polyploid's evolutionary history.

While revisiting the Big Creek subwatershed on 05/31/2012 and scoping out the granitic, sandstone-capped cliffs directly above the old quarry, I spotted several clumps of *D. caespitosa*, ca. 25+ m above me, and for the moment out of reach but validating the continued existence of this complex taxon in this ancillary drainage system withinin the Scott Creek Watershed proper.

55. The carices (*Carex* spp.) found within the Scott Creek Watershed and environs present several unresolved, misunderstood, and inherently significant issues that offer the student of evolution and speciation an opportunity to make a valuable contribution, not only towards clarification of several key diagnostic problems but creating a baseline that brings in to focus the significance that disturbance regimes, both natural and anthropogenic, have in broaching reproductive isolating mechanisms and allowing the exchange of genetic material that otherwise would not occur [see #45].

The taxon that I have designated *C.* x "imperfecta" is a potential Rosetta Stone in understanding the possible origins of both the *C.* "gianonei" (*C. harfordii* matrix with lower 1–5+ spikelets compound-congested, spikelets androgynous and/or gynaecandrous) and *C.* x "nitidicarpa" (*C. subbracteata* matrix reflecting *C. densa* traits and fertile as to reproductive capacity) complexes.

By focusing on *C.* x "imperfecta", with its complex inflorescences displaying very specific traits that link two distantly related sections—the Multiflorae and Ovales—an important contribution can be made to the ongoing research being done relevant to this very difficult genus and in the specific case of *Carex* x "imperfecta"—a taxon that has no validated existence in either the historical or current literature.

As an entity unto itself independent of its evolutionary relationships with *C.* "gianonei" and *C.* x "nitidicarpa", *C.* x "imperfecta" is represented by at least 200 separate plants occurring on the coastal prairie between the Pumpkin Field Marsh and the China Ladder Marsh, with localized populations documented for Beaver Flat, West's Spring, and Marti's Park Marshes. Many envelopes containing 200+ *C.* x "imperfecta" inflorescences have been deposited with the UCSC Arboretum, and at least two dozen living representatives of this taxon are also ensconced in the new California section with future collections/deposits planned.

Relative to the pistillately non-functional inflorescences of *C.* x "imperfecta" is another observation that may have both a structural and evolutionary bearing of this yet-to-be fully diagnosed taxon. On many of the inflorescences, post shedding of pollen and failure of the ovules to develop, a white fungus appears to invade the spikelet(s) between the inner face of the perigynial sac and the rachis.

a) Does the presence of this pathogen correlate with the "imperfect" nature of this hybrid taxon, aneuploidy, and the resulting imcompatibility factors between two distantly related species? And/or is the habitat, with its proximity to protracted air-born oceanic moisture at a time when seasonal rains are over and terrestial moisture is minimal a relevant factor? The fungal pathogen invading the mature inflorescences does not appear to affect the vigor of the plant or its overall biomass, and several of the *C.* x "imperfectas" have been continually observed/studied for more than three decades!

b) Using the coastal prairie/Western Terrace between Scott Creek Marsh and the Lasher Marsh Gulch as a living laboratory for the study of the carices, determine if the inflorescence-invading fungus is restricted to the *Carex* x "imperfectas" (and are all or only some plants colonized), or are other *Carex* species so afflicted?

c) With many of the *Carex* x "imperfectas" producing/shedding pollen,

1) What is the fertility of said pollen and does it vary from plant to plant?

2) What role does/has the hybrid pollen play(ed) in backcrossing/outcrossing with related taxa, members of the Ovales section in particular?

3) Does the inflorescence-contaminating fungus affect the pollen development/viability of the *Carex* x "imperfectas", or does the onset of this pathogen take place after the pollen has been shed and the ovules within the perigynial sac fail to develop properly?

56. Clarify the taxonomic status of *Sanicula* "gianonei", pro. sp. nov. by comparing/analyzing the consistent differences between this potentially undescribed taxon and the species it has been subsumed under/confused with—namely *S. crassicaulis*.

a) Define the overall range of *S.* "gianonei" and within that geographic circumscription, examine the following issues:

1) Habitat preference/ecology/range of tolerance within a mesic to xeric context, since this taxon, with rare exceptions, prefers seasonally moist shaded bottomlands within riparian corridors or their equivalent habitat found in semi-shaded transitional zones, between mixed conifer/oak woodland and grassland, usually growing as a *Baccharis/Toxicodendron* understory component.

2) Do a detailed work-up of this entity's chemical signature throughout its range, defining its consistency relative to that range and what constituent chemical components it shares with *S. crassicaulis* and which biochemical properties are unique to it.

3) Examine the stems and petioles as to shared or distinct pigments and their patterning plus structural characteristics such as fistulose versus stems filled with pith and external ribbing. Also, examine below-ground rootstocks and potential differences in their average life expectancy.

4) A comparison between *S. crassicaulis* and *S.* "gianonei" as to foliar topography is critical, for the major differences are both consistent and distinctive: thickness of epidermis, its pigmentation and veinal patterning, and most important, the type of marginal trichomes and their behavior as the leaf ages.

5) Parenthetical to the previous lines of analysis is the need to do a chromosomal study to see if *S. crassicaulis* and *S.* "gianonei" are both tetraploids; and if so, are there still significant differences between these two taxa on a DNA level?

6) Study the flowers and their coloration and the epigynous discs as to umblemished versus a scurfy coating.

7) Follow the development of the schizocarps, noting the placement/organization of the "bristles" from the base to the apex of the fruit and whether they are in a graduate or fairly uniform series. Also, the color and ultimate configuration of the schizocarp body post-anthesis.

57. Long-lived, rhizomatous Asteraceae (e.g., *Eurybia radulina*, *Solidago elongata* and *Symphyotrichum chilense*)—

a) Is there a correlation between low-viability cypselae (achene) production in these species and their capacity to form long-lived, rhizomatous colonies with the principal emphasis on vegetative expansion and/or the seasonal impact of diurnal lepidoptera and their larval stage using the developing cypselae as a primary food source?

b) What impacts on the population's overall genetic diversity does this have, if many of the "established colonies" are possibly clonal?

c) Do some of these pistillately non- or poorly functioning "populations" act as males, passing on some of their genetic material via vectors to other populations that have fully functional reproductive parts?

d) Is this compromised gene-flow pattern a permanent condition, or does it vary throughout the flowering season and from year to year?

e) Is it a physiological response to a set of environmental conditions that are site specific and do not necessarily reflect the aformentioned taxa throughout the Scott Creek Watershed and its environs?

f) *Solidago elongata*, an uncommon species countywide, tends to frequent old marshes in the Swanton area (e.g., Beaver Flat, West's Spring, China Ladder), and all the populations studied to date follow the pattern of low-viability cypselae counts and extensive asexual/vegetative colonization. Map this species within the watershed/environs and determine if some/all of the "populations" are principally clonal with little genetic variability and examine the mature capitula for evidence of larval activity.

g) This same methodology should also be applied to the far more ubiquitous *Symphyotrichum chilense* populations, which exhibit the same pattern of poor "seed set" and form extensive "colonies" via rhizomes.

58. Photo-documentation of area burned by Lockheed fire—The Schoolhouse Ridge Complex, unique not only from an ecological/botanical perspective but a geomorphological one as well, was severly impacted by the 2009 Lockheed Fire. Two days after the fire was being defined "officially under control," I spent five consecutive days photo-documenting with 1,000+ images all aspects of this anthropomorphic-induced holocaust, showing the after-effects on this previously designated botanical "hotspot."

While, both the pre- and post-fire "native" plant inventories have been meticulously recorded in the accompanying essay, no follow-up series of photos, paralleling my original 5 sets have been done. With a before/after botanical overview of this complex and diverse ridge/gulch/grassland/riparian corridor series of interconnected ecosystems already in place, a second series of photos would create an important baseline from a successional perspective.

59. *Clarkia* spp.—With the Scott Creek Watershed and environs hosting multiple populations of *Clarkia* aff. *davyi*, *Clarkia* aff. *prostrata*, and *Clarkia purpurea* subsp. *purpurea*—all three taxa of rare or uncommon status within Santa Cruz County—an in-depth study is in order to clarify their taxonomic status relative to the original typification.

a) If the *C.* aff. *prostrata* is found to possess a chromosome number of n=26, is this the result of hybridization between *C. speciosa* (n=9) and *C. davyi* (n=17)? Or is this local taxon distinct from the putative hybrid described from San Luis Obispo County and a valid/undescribed species in its own right?

b) Since most of the populations of these three *Clarkia* species are self-contained and isolated from each other, are there inter-populational differences genetically coded, or are they remnant fragments of a once more continuous distribution pattern?

c) With Andrenid bees being the principal pollinating vector for the local clarkias and no intermediates/ hybrids found where populations of *Clarkia* aff. *davyi* and *Clarkia* aff. *prostrata* overlap, and their phenologies being concurrent, is the difference in chromosome numbers the principal reproduction isolating mechanism?

d) With the UCSC Arboretum custodian of 50+ in situ seed/capsule collections for *C.* aff. *davyi*, 30+ in situ seed/capsule collections for *C.* aff. *prostrata,* and 30+ in situ seed/capsule collections for *C. purpurea* subsp. *purpurea,* plus several dozen ex situ raised collections drawn from populations within the overview of this Essay, it is very important to consider that several of these populations are no longer extant or accessible, and the recruitment of those still in existence are subject to the vagaries of seasonal weather patterns, competition from fellow travelers of the non-native variety, and various challenges from indiscriminate herbivores.

60. Effects of insect herbivory on certain members of the Asteraceae—Several genera within the Asteraceae, while producing sexually functioning capitula, are repeatedly targeted by what appears to be species of diurnal lepidoptera (or some other members of the Class Insecta), whose larval stage often destroys substantial portions of the developing ovules, rendering the mature inflorescences with a minimal amount, if any, of viable seed. Within the Scott Creek Watershed and environs, the following taxa over the course of several seasons have been observed bearing the ravaging effects of this yet to be determined "spoiler":

- *Heterotheca sessiliflora* subsp. *bolanderi*
- *Pseudognaphalium biolettii*
- *Pseudognaphalium californicum*
- *Pseudognaphalium* "gianonei" pro. sp. nov.
- *Pseudognaphalium ramosissimum*
- *Pseudognaphalium stramineum*
- *Solidago elongata*
- *Symphyotrichum chilense*
- *Symphotrichum subspicatum*

a) Determine the family/genus/species of insect that is causing the damage to the developing ovules. Is the species a generalist in choice of host plant, or are there more than one egg-laying species involved, each specializing in a specific taxon possibly due to the host plant's distinguishing chemical signature?

b) With *Pseudognaphalium* spp. being relatively short-lived non-rhizomatous perennials, how does the substantial ovule destruction affect the host species' recruitment capacity and the subsequent resegregation of genetic material?

c) Since the *Solidago* and *Symphyotrichum* spp. create extensive "clonal" populations via rhizomes and are exceedingly long-lived, and if the ovule destroying larvae infestation is cyclical—does the longevity of the rhizomatous species offset the short-term loss of sexual reproductive capacity?

d) Within a given area, are all representatives of the aforementioned Asteraceae members targeted by the egg-laying insects, or is there a co-evolving interplay between "predator and prey," where those taxa previously attacked make genetically transmitted changes in their biochemistry, rendering future generations less palatable to predation.

61. *Arctostaphylos crustacea* subsp. *crinita*—With the current circumscription of this taxon at variance with the polymorphic populations found within the Scott Creek Watershed, revisit the subspecies from a molecular perspective and determine if this taxon is a "genetic sponge."

a) Are both clades represented in the Scott Creek Watershed genome of *A. crustacea* subsp. *crinita* (with *A. andersonii*, *A. glutinosa* [referencing both *A. andersonii* and *A. canescens* genes], *A. sensitiva,* the ancestral influence of *Arctostaphylos uva-ursi,* and the current association with *A. crustacea* subsp. *subcordata* [where the inferred presence of the former and documented existence of the latter occur sympatrically on the Schoolhouse Ridge] morphological fingerprints appearing throughout the population)?

b) Leaving the Scott Creek "Chalks," where tetraploid *A. crustacea* subsp. *crinita* co-exists with at least four diploid species, do a genetic profiling of the lower-elevation, isolated *A. crustacea* subsp. *crinita* populations that occur within several disjunct chaparral communities and see if they possess less complex parentages and earlier speciation patterns.

c) As one progresses up the Schoolhouse Ridge towards the "Chalks," the overall gestalt/physical profile of individual *A. crustacea* subsp. *crinita* plants is so variable that one can take fewer than 30 steps and observe what appears to be two or three dozen distinct taxa, all linked by a basal burl. Are all these "phases" of *A. crustacea* subsp. *crinita* basically the same on a molecular level, or are some of the more extreme (divergent from the type) foliar/floral patterns supported by equally distinct genetic fingerprints?

d) Is pollen fertility lower in this taxon due to its polyphyletic origin, which incorporates species from two different clades?

62. *Castilleja affinis* complex—Examine the putative polyphyletic nature of the *C. affinis* complex residing within the Scott Creek Watershed and environs to determine if the following taxa's genes, in varying degrees, are represented within the genome of *C. affinis*, an extremely variable taxon.

a) *C. subinclusa* subsp. *franciscana* (upswept apices of calyx/exserted galea from below lower lip, pedicellate flowers);

b) *C. applegatei* (combination of glandular herbage with wavy leaf margins);

c) *C. latifolia* (leaves and bracts oblong/sub-entire and thick);

d) *C. foliolosa* (occasional forked trichomes); and

e) *C. wightii* (bracts/calyces yellowish in coloration, galea barely exserted, inflorescences congested and along with multi-branched stems and herbage, sticky-glandular).

In the early 1980s, comprehensive collections/pressings were made from the Swanton area and deposited with the UC/Jepson Herbarium for study/diagnostic usage and incorporated into Dr. Lawrence Heckard's ongoing *Castilleja* studies. All of the above-described characteristics, in various combinations, were found in the specimens collected—some as solitary examples, while others reappeared throughout the watershed.

63. DNA investigations—Within the area defined by this essay, there are several native taxa or related sets of taxa that need relationship clarification on a molecular level. Some of these problematic areas, which could provide lines of research in systematics, speciation, co-evolution, and reproductive isolating mechanisms, are as follows:

a) The relationship between *Luzula comosa* var. *comosa* and *L. subsessilis*, which have overlapping seed size/shape and style lengths.

b) *Triteleia laxa*—(the widespread forma typica) versus the distinctive coastal headland form, as to habitat, stature, flower shape/color, filament/anther presentation and breeding behavior.

c) The relationship of the localized *Brodiaea* aff. *elegans* complex (growing across the exposed grass-covered crest of the Seymore Hill) relative to the *B. terrestris* subsp. *terrestris* populations, scattered throughout the lower elevation grasslands within the Scott Creek Watershed and the coastal prairie aka Western Terrace.

d) Revisiting the *Fritillaria affinis* complex locally, from both an ecological and molecular perspective and elucidating the status of the distinctive coastal bluff isolate, which shows affinities to the taxon found north of San Francisco Bay formerly classified as *F. lanceolata* var. *tristulis*.

e) On the north end of Swanton Road, growing on the seasonally moist bedding planes that constitute the original Highway 1 (above and overlooking Washout Turn) are populations of *Isolepis carinata* and *I. cernua* (locally rare annual form) growing so intermixed that one could easily mistake the two taxa as one polymorphic entity.

1) With a shared phenology and physical proximity, is there any exchange of genetic material, and is it even possible? Or, are these two related taxa reproductively isolated?

2) With the principal form of *I. cernua* locally being perennial and primarily restricted to year-round moist edges of the coastal prairie and near-vertical cliffs proximal to the ocean, and the annual form found in seasonally wet habitats, are there differences on a molecular level between these two forms that are co-evolved with the underlying hydrology?

Is this annual/perennial dimorphism analogous to the local behavior of *Erythranthe grandis*, which can have what purports to be annual growth status growing on seasonally wet waterfall/cliff faces overlooking the gulchlets draining under Highway 1, while a perennial, rhizomed form grows locally in continually moist ditches and coastal marshes?

64. Differing forms of two genera in the Asteraceae/Tribe Astereae—The Scott Creek Watershed and environs plays host to two genera within the Asteraceae/Tribe Astereae that have elevationally differing forms that parallel each other, namely: *Corethrogyne filaginifolia* var. *filaginifolia* and var. *californica* and *Heterotheca sessiliflora* subspp. *bolanderi* and *echioides*.

a) What are the evolutionary advantages/selection pressures in having the immediate coastal forms being low-growing in stature and with few- or single-flowered inflorescences compared with the more interior/higher-elevation relatives, with often rigidly erect growth patterns and inflorescences with numerous, smaller in stature, flowers?

b) Are both forms of each taxon independently derived from a previously existing species, or is one of the two existing forms older and the other form derived from it?

c) Within a given locale, even if the two forms are interfertile should their ranges overlap, if one of the two forms were to disappear, is the other form genotypically stable enough that it would breed true to its type even if it were the derived form?

d) Following up on the previous question, what constitutes a species if closely related taxa capable of gene exchange when occurring sympatrically show no intermediacy when geographically separated?

e) Factoring in the different chemical signatures of the two *Heterotheca* subspecies, what other differences exist on a molecular level between these two sets of related taxa that allow for exchange of genetic material where both types occur sympatrically, but when isolated over time could theoretically result in speciation?

65. *Isolepis cernua* phases (see 63e)—On the ocean side of the Santa Cruz Syncline, mainly on what is termed the Western Terrace, two taxa lumped as one species (*Isolepis cernua*) occur, but not sympatrically. The perennial phase of *I. cernua* occurs mainly on wet seeps/cliff faces overlooking the ocean with a few isolate populations growing in hydrologically unique "lens" along the edge of the Western Terrace, while the singularly uncommon annual form, has been found only twice, growing intermixed with *I. carinata* on exposed, seasonally moist bedding planes that constituted the original Highway 1 (north end of Swanton Road above Washout Turn), and

growing without the companionship of *I. carinata* along a seasonally moist dirt road, between Big Willow Marsh and the Frog Pond.

a) Are these two phases of *I. cernua* one and the same species or are they two separate entities, which if studied from a molecular perspective, would both prove to be valid but distinct taxa in their own right?

b) Where *I. carinata* and *I. cernua* occur intermixed on the original Highway 1 roadbed, is there any gene flow between these two related taxa and what are the ecological underpinnings that allow two related annual species, one uncommon and the other rare (*I. carinata* and *I. cernua*), to co-exist in such proximity, while the two "forms" of *I. cernua*, at least in the area covered by this essay, display no evidence of sympatry? Is the local annual form of *I. cernua*, in actuality, an undescribed but related taxon?

66. *Rumex salicifolius* complex—With three members of this complex occuring within the area (*R. californicus, R. crassus*, and *R. transitorius*), and two of these taxa found growing sympatrically, several taxonomic issues need to be addressed:

a) On a molecular level, are each of these three taxa sufficiently distinct to warrant species status?

b) What vectors (wind, insects or autogamy/self-fertilization) act as pollinating mechanisms?

c) Where these taxa occur sympatrically, as with *R. californicus* and *R. transitorius* along Swanton Road, is gene flow (reciprocal or unilateral) possible, or are these two "species," reproductively isolated?

d) Two non-native *Rumex* species (*R. conglomeratus* and *R. crispus*), both vertically aligned taxa, are also growing sympatrically with *R. californicus* and *R. transitorius*. Is gene exchange possible, and if so, is there any evidence of such hybridization in the Swanton Road populations?

e) If a large sampling of achenes from the sympatric plants of *R. californicus* and *R. transitorius* growing along Swanton Road were raised out, would the offspring of both taxa come true to type?

67. Do a comparative study of the climbing (scandent) native taxa within the Scott Creek Watershed from an engineering perspective and investigate the structural efficiency of the various solutions each species has arrived at—the differing strategies being as follows:

- *Antirrhinum kelloggii* (aerial stems supported by elongate, filiform pedicels);
- *Calystegia purpurata* subsp. *purpurata* (aerial stems twining);
- *Lathyrus vestitus* subsp. *vestitus* (tendrils derived from rachis);
- *Lonicera hispidula* (aerial stems long lived, sub-ligneous with age, and bearing a strong resemblance to the lianas of the tropics);
- *Toxicodendron diversilobum* (aerial stems often reaching 15–20+ meters and attached to tree trunks by adventitious rootlets);
- *Clematis lasiantha* (climbing stems subligneous and anchored by petioles of the opposite compound leaves);
- *Galium porrigens* var. *porrigens* (scandent, multi-branching aerial stems retrorse-scabrous along stem edges); and
- *Marah fabacea* (usually branched tendrils, emerging out of stems opposite leaves).

Recently observing the California man-root in situ, I noticed that the usually trichotomous tendrils behaved in two concurrent patterns. When the tendril branch was not in contact with any surface, it remained more-or-less straight without any coiling, while a sister tendril branch in direct contact with any supporting structure immediately started coiling around said anchor and ultimately the entire tendril branch formed a spring-like coil, giving both stability when no air motion was present but flexibility during peak periods of turbulence.

68. Starting with the documented existence of *Juncus hesperius* x *Juncus patens* hybrids and the raising from in situ collected seed an F2 generation:

a) Investigate whether the variability of the local parental populations is wholly the result of intraspecific gene flow, or do the sympatric occurring F1 hybrids (due to their longevity/potential for selfing, outbreeding, and apomixis) have some influence on either or both parents?

1) Do DNA profiling of both parents growing proximal to any given hybrid and look for hybrid genes or fragments thereof, within the parental genomes.

2) Investigate whether some or all hybrid inflorescences begin with pollen/stigmas maturing at differing times, with the gradual development of the inflorescences shifting to a self-pollinating mode, and ultimately some flowers displaying apomictic behavior—or, in sequential terms, possibly mixing it up.

69. *Acmispon americanus* var. *americanus*—This relatively low-growing native annual acts as a weed supressor, fixes atmospheric nitrogen, and provides a food source for pollinating bees. In addition, it requires minimal water in summer, offering managers of orchards and similar agricultural venues a local taxon relatively easy to obtain seed from, and once established, self sowing. This is a research project eminently worthy of consideration, with the in situ behavior of said taxon easily observed from Swanton Road and the adaption from a naturally occurring environment to orchard use presenting few if any ecological problems.

70. Do an ecological, morphological, and molecular review of the reduced-in-stature coastal headland/bluffs (between Greyhound Rock and Scott Creek beaches) taxon, tentatively placed within the *Elymus glaucus* subsp. *virescens* circumscription and compare with

a) the type from the Olympic Mountains; and

b) coastal headland populations north of San Francisco Bay (e.g. Bodega Bay, Sonoma County).

c) Is absence or presence of an awn (1–7 mm) on glumes and lemmas the principal character used to distinguish subsp. *virescens* from subsp. *glaucus*, and if so, does the gross difference in overall stature between the the immediate coastal bluff taxon and the ca. one-mile inland form (separable from subsp. *glaucus*, not in stature but by absent awns on glumes/lemmas) represent an ecological rather than genetically imposed difference?

d) If the coastal bluff taxon is a genetically stable and separable from subsp. *glaucus* on either a species or subspecies level, are the populations (looking like short-awned to awnless *Elymus glaucus* subsp. *glaucus* plants) between the north end of Swanton Road and the Last Chance Road the result of introgressive hybridization between these two taxa?