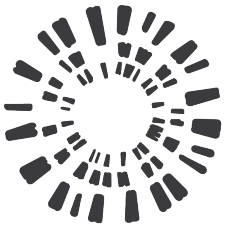

Santa Barbara
Botanic Garden

GAP Analysis of the California Channel Islands: Bryophytes

Final Report
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Executive Summary

There are currently 189 bryophyte species known from the Channel Islands (156 mosses, 29 liverworts and 4 hornworts). The large majority of these species (all but four) are native, and introduced/invasive species are not interpreted as an important threat. Systematic collecting on the islands only began in the mid 2000's, with a small number of earlier collections made mostly by vascular plant collectors. Species accumulation curves indicate that sampling is not complete on any of the eight islands. Collecting has focused on the five largest islands where there is enough work completed to indicate the rank order of richness across the islands but also indicating the extent to which each island flora is incomplete. Sampling across the smaller islands is much less intensive, but future effort is not anticipated to substantially increase the number of species known from those islands based on their physical characteristics. Sampling on the larger islands has been performed across all of the major vegetation types, but large areas across all of the islands remain unexplored. Collecting and herbarium work has continued since the most recent checklist of island bryophytes (Carter 2015) and this report includes 56 new island records from the published literature and ongoing herbarium study. Highest priorities for future work on the islands include: 1) general collecting on San Miguel Island and Santa Barbara Island, 2) focused collecting in soil crusts across all islands, 3) focused collecting in higher elevations from Santa Cruz Island and Santa Rosa Island and from the eastern gorges on San Clemente Island.

I. Introduction

Bryophytes, sometimes called 'non-vascular' plants, include three evolutionarily distinct lineages, the mosses, hornworts and liverworts. Together they comprise three of the four major branches of the land plant tree of life, with all of the vascular plants (lycophytes, ferns and seed plants) constituting the fourth branch. Most of the bryophyte life cycle occurs within the haploid gametophyte stage, and these gametophytes, at least for the species that thrive in southern California, are mostly desiccation tolerant. Many species are perennial and remain dry, dormant and desiccated throughout the summer and then resume metabolic activity during the rainy winter months. Ecologically and physiologically, they share as many characteristics with lichens as they do with the vascular plants.

There are around 2000 bryophyte species in North America, and around 800 in California alone. In round numbers, there are perhaps 650 mosses, 150 liverworts and a half dozen hornworts within the state. All bryophytes, but especially liverworts, demonstrate a strong diversity gradient across the latitudinal moisture gradient spanning California's long axis. This gradient is evident on the Channel Islands, with a number of relictual northern species occurring on the fog draped ridgelines and deep canyons of the north islands, and the absence of these on the southern islands.

Bryophyte floristics and biogeography on the Channel Islands is in its early stages, but recent work on the islands makes the archipelago one of the better understood regions along the California coast south of San Luis Obispo county. This report provides a summary of the current

state of knowledge and most promising future directions for continued effort in the coming decades.

II. Ideal Future State

Ideally, the bryophyte flora of the Channel Islands would be well enough understood that future changes to the bryophyte flora, for example as caused by climate change, continuing recovery from ungulate removal, and the continuous introduction of invasive plants, could be detected by comparison to a baseline. This baseline, ideally, would include systematic sampling based on both geography and vegetation type. Even coarse estimates of abundance would likewise be useful in documenting future change.

III. Current State

In this section, the collecting history of bryophytes on the Channel Islands is briefly discussed. This is followed by a description of the methods used in this GAP analysis and the results and interpretation of the analysis. Conclusions and Recommendations follow in section IV.

III.a. Background

III.a.1. Collecting History- The history of bryophyte collecting on the Channel Islands was thoroughly summarized recently by Carter (2015). That report includes all known published literature on Channel Islands bryophytes, locations of all known historical and recent herbarium specimens, and a history of collecting on the islands. Since 2015, there have been a handful of new records based on previously undetermined specimens, but the only real progress has been several collecting trips to San Nicolas Island. Some, but not all, of the new finds from those trips have been published (Carter 2017, Carter et al. 2018).

The following is a very brief synopsis of the collecting history on the islands summarized from Carter (2015). Collections throughout the 20th century total perhaps a few hundred specimens and are mostly made up of sporadic collections by vascular plant collectors with no formal training in bryology. The history of collecting, and the current location of historical vouchers for those that have been relocated, were thoroughly reviewed by Carter (2015). The first substantive collecting on the islands was a trip to Santa Catalina Island (vicinity of White's Landing) by the bryologist W.C. Steere in 1953. The next collecting trip by a bryologist was a relatively thorough collecting expedition (several hundred collections) to Santa Rosa Island by Dan Norris (UC Berkeley) and Jim Shevock (California Academy of Sciences) in 2004. My own work on the islands began in 2010 and has resulted in approximately 2000 collections from seven of the islands (all but Santa Barbara). Cedrick Villaseñor made the only important collecting trip to west Anacapa Island in 2009.

III.a.2. Introduced species- In general, there are very few invasive bryophyte species globally and they tend not to be particularly ecologically problematic. The accepted hypothesis explaining this pattern is that, since bryophytes are generally very strong dispersers, they mostly dispersed to places where they could thrive ecologically prior to substantial human-mediated dispersal. As

a result, new introductions of bryophytes tend to be infrequent and, when they do occur, they rarely invade communities and displace native species in the way that vascular plants do.

On the islands, there are four documented introduced species. One of these, *Marchantia polymorpha*, is native to California but has a distribution that strongly suggests human introduction (Carter 2015). Another, *Lunularia cruciata*, is known only from flower pots in Avalon on Santa Catalina. The third, *Fissidens curvatus*, is a ubiquitous species of annual grasslands. The fourth, *Campylopus introflexus*, is one of the very few bryophytes that has a record of invading intact bryophyte and lichen communities. It occurs only in the higher elevations on Santa Cruz Island, especially in the Bishop Pine forest, where there are several areas that have dense carpets of the species. This suggests that it might be a species worth monitoring. The ecology and biogeography of *C. introflexus* in western North America, including on the Channel Islands, was discussed in detail by Carter (2014).

III.a.3. Listed species- There are currently no state or federally listed bryophytes known from the Channel Islands. *Tortula californica*, which is not uncommon on the islands, is currently listed by the California Native Plant Society at the rank of 1B.2 (rare, threatened, or endangered in California and elsewhere; moderately threatened in California), but it is likely to be de-listed due to increasing understanding of its distribution throughout southern California. *Geothallus tuberosus*, which has a state rank of S1 (CNPS rank 1B.1; (rare, threatened, or endangered in California and elsewhere; seriously threatened in California) is not known from the islands, however it occurs in coastal scrub in San Diego county in habitats that are well represented on Santa Catalina and San Clemente Islands. As a small and very short-season ephemeral, it would be quite easy to miss. As southern California botanists over the last 5-10 years have come to understand the natural history of the species, a number of new mainland populations have been documented.

III.a.4. Endemic species- There are currently no known Channel Island endemic bryophytes. An important near-endemic is *Frullania catalinae*. This species has a distribution similar to *Leptosyne gigantea*- very common on the islands and rare on the mainland with a few scattered populations from San Luis Obispo to San Diego counties. It is an epipiphyte and occurs only on islands with large populations of woody species (especially *Quercus pacifica*).

III.a.5. Undescribed species- There is one putative undescribed species of *Plagiobryoides* (Bryaceae) based on a single collection from Santa Catalina Island (pers. comm. J. Spence, National Park Service, Glen Canyon National Recreation Area; see also Carter, 2015). After the collection was recognized as putatively representing a new species, the site was revisited in an attempt to relocate the original population and to document additional populations. Neither was successful, but as the habitat was not apparently unique, future work may yield additional populations.

III.b. Methods

III.b.1- Data collection- Because the large majority of specimens from the islands (more than 90%) have been collected in the last 20 years, this study relied primarily on specimen records available from the Consortium of North American Bryophyte Herbaria (https://bryophyteportal.org/portal/). This database is the result of a recent National Science

Foundation (NSF) funded grant that resulted in the attempted digitization of all North American bryophyte collections in North American herbaria. A small number of specimen records from San Jose State University (SJSU) that have not yet been uploaded to the Bryophyte Consortium were also included. These records will eventually be uploaded to the Consortium. The accessibility of the Consortium data, in addition to the large proportion of recently collected specimens, allowed for an analysis of the large majority of specimens that have been collected from the islands. The small proportion of earlier collections (reviewed by Carter 2015), which are not georeferenced, do not contribute significantly to either richness or to spatial collection patterns. In the dataset analyzed, 2.5% of collections were made prior to 2000, and 97.5% were made after 2000. There are certainly more early collections than that (which were not included here because they are not georeferenced), but the number is small.

III.b.2- Data analysis- All data analyses, including spatial analyses, were performed using custom R scripts. Species accumulation curves are the result of randomly reshuffling all collections from each island 100 times and then finding the mean species accumulation across increasing numbers of collections. Spatial analyses (e.g. collecting intensity and species richness per 1 km grid cell) were performed using standard functions in the R 'raster' package (Hijmans 2020). For these analyses, a regular 1km grid was established after converting all specimen geolocations into an equal area (Albers) projection with all specimens assigned to the grid cell in which they were located.

III.c. Results

III.c.1 Species accumulation curves- Curves indicate that sampling is not complete for any of the islands, but that most of the islands have curves that have begun to flatten out (**Figure 1**). The total number of moss, liverwort and hornwort species across the islands also varies among islands (**Table 1**).

The four small islands: Three islands remain very poorly sampled- San Miguel, Anacapa and Santa Barbara. Despite the low sampling, I anticipate that additional collecting will not yield many more species for either of those two. West Anacapa Island has been reasonably well collected (ca. 50 specimens) and the best vegetation on the north side of the islet was visited so all of the best bryophyte habitat has been surveyed reasonably intensively, if only once. It is likely that greater effort will sharply flatten the accumulation curve for that island and there are few other species (e.g. from Santa Cruz Island) that would be expected. San Miguel Island's curve is already flattening, despite having a richness only half of Anacapa Island's. It is a much larger island, and has only been surveyed once, but it lacks suitable habitat for bryophytes. The low maximum elevation, generally sandy soil, lack of large shrubs or trees and limited rock outcrops all likely contribute to the low richness. Although the number of specimens is low, the ravine from Cuyler Bay has been surveyed relatively heavily and appears to be one of the most promising habitats on the island. Future effort is certainly warranted, but may not yield much. Particularly instructive is the curve for San Nicolas Island, another low island with predominantly sandy soil. Although not particularly well sampled, it has the flattest of the curves among the five largest islands. Santa Barbara Island has only six collections representing six different species. While sampling is clearly incomplete, there are not likely to be many more species. I spent a full day on east Anacapa Island and found only five species on that islet. The

combination of unstable soil and high perimeter/area ratios of these small islands (few bryophytes are tolerant of salt spray) make them unsuitable for most bryophyte species.

The four large islands: Sampling has been relatively robust across the four large islands. Santa Catalina and Santa Cruz Islands have very similar accumulation curves. In a biogeographic analysis, Carter and Guilliams (2018) found that island area and maximum elevation were both very strong predictors of bryophyte richness, while distance to mainland was a generally poor predictor. Area, and especially maximum elevation, correlate with vegetation heterogeneity and microsite heterogeneity. This likely explains the clear difference between the curves of Santa Rosa and Santa Cruz Islands, with Santa Rosa having a similar slope but lower accumulation. While sampling on San Clemente Island is much lighter than on Santa Catalina Island, it is clear from the curve that observed richness on San Clemente Island will remain lower even with greater sampling. San Clemente has deep gorges along the eastern face that provide good habitat, however it lacks the extensive woodlands that occur on Santa Catalina and has generally lower habitat heterogeneity. That said, further exploration of the east facing gorges is likely to be productive.

III.c.2 Spatial analyses within islands- Spatial gaps were assessed numerically and visually with the aid of maps. In both cases, the islands were separated into 1km2 grid cells and richness and collecting intensity (number of specimens) recorded for each grid cell (**Table 2**, **Figures 2,3**). Santa Barbara Island was not included because, although six species are known from the island, there are no georeferenced specimens.

For all the islands, a large proportion of the landscape remains unexplored (zero collections per grid cell). The percent of empty 1 km^2 grid cell calculations in Table 1 are somewhat inflated because no correction is made for the fact that gridcells along coastlines often have very little terrestrial surface. Regardless, the combination of a high proportion of empty cells and relatively low redundancy for cells that do have collections is an indication that the islands are not particularly well explored bryologically. This interpretation is supported by the fact that redundancy is negatively related to island richness. This is an indication that, although the majority of species have likely been documented, their ranges throughout the islands are currently not well understood. Another indication of this is the relatively low number of collections per taxon (see next section).

Maps of collecting intensity and collecting sites (**Figures 2,3**) provide a clear overview of spatial collecting bias throughout the islands. Predictably, bias is strongly associated with both accessibility and, to a lesser extent, targeting of putatively interesting sites (e.g. pine forests). In several cases, especially on Santa Cruz Island, large areas remain completely unexplored. Even for islands with relatively good spatial coverage (e.g. Santa Catalina and San Nicolas Islands), the collecting intensity is relatively low throughout.

III.c.3 Distributions across islands- Another indication that collecting intensity has been relatively low is that very few species are known from all eight islands (**Figure 4**). Currently, more than 25% of the species known from the islands are known from a single island, while fewer than five percent are known from either seven or eight of the islands. Some of this is biological- there is very little suitable habitat on San Miguel and Santa Barbara Islands, so there are very few species that occur on these islands. Differences between collecting effort and habitat suitability can, to a greater extent, be determined by identifying “missing” species- those

that might be expected on an island but which are not yet recorded. For example, species that are recorded from three of the large islands but which are absent on either Santa Cruz or Santa Rosa Island are small, sporadically distributed soil crust mosses suggesting that these have been overlooked (**Table 3**). Conversely, species not yet recorded from Santa Catalina or San Clemente Island include similar sporadically distributed soil crust species but also include robust mesic species that are unlikely to be overlooked. On San Clemente Island, some similar species have been found in deep gorges in the eastern escarpment and further exploration in those areas may very well uncover some of these species.

Using a similar approach, undetected species are informative when comparing across the northern islands (**Table 4**) and the southern islands (**Table 5**). Species that occur across most of the northern islands but are absent on Anacapa Island are all common soil crust species across the archipelago; it is likely that a large proportion of these occur on Anacapa Island but have been overlooked. San Miguel Island lacks a number of these species as well, but is more characterized by a lack of epiphytes and species that favor protected canyons. These habitats, while not abundant on west Anacapa Island, are substantial enough to support several species absent on San Miguel Island. In the south, the species absent from San Nicolas Island are habitat generalists that could be overlooked relatively easily. The long list of species missing from Santa Barbara Island certainly reflects the lack of collecting effort but also includes species that are almost surely excluded by a lack of suitable habitat.

III.c.4 New Records- Since the Carter (2015) checklist, nine new species have been recorded from the Channel Islands and a total of 55 new island records (first record of a species on an island) have been made. Approximately half (~56%) of these come from several collecting trips to San Nicolas Island, with some of the new records reported in the literature since the 2015 checklist (Carter 2017, Carter et al 2018). The remaining are the result of identification of previously unidentified or misidentified herbarium specimens. **Appendix I** provides a list of all the new records with either a voucher specimen or a literature citation which cites a voucher.

III.c.5 Taxon bias- Because all of the major collectors of Channel Island bryophytes have been taxon generalists, there was no expectation of taxon bias. There is only one relevant and ecologically comparable mainland bryophyte flora to serve as a comparison, which is the flora of the Santa Monica Mountains (Sagar 2007). With circa 119 species (as compared to the 166 species reported for the islands), it is roughly similar in species richness and is also similar ecologically to the islands. A comparison of major taxonomic groups between the islands and the Santa Monica Mountains does not provide any indication of taxon bias. There are minor differences, for example more Pottiaceae and Grimmiaceae represented in the Santa Monicas and more Bryaceae and Leafy Liverworts on the islands. These are likely explained ecologically, with Pottiaceae and Grimmiaceae over-represented in the relatively drier mainland mountains and Bryaceae and Leafy Liverworts over-represented in the more mesic maritime climate of the islands.

IV. Priorities to proceed from Current State to Ideal Future State

Collection of the bryophytes on the Channel Islands is certainly inadequate, but the efforts that have been made have been relatively systematic spatially, with a clear effort to sample broadly across islands and across vegetation types within islands. The proportion of unidentified specimens is very low, as is the number of specimens that lack georeferencing. The large majority of specimen data are available online and most specimens are housed in actively curated herbaria (especially UC, CAS, SJSU- see Carter, 2015 for full list). Below are my recommendations, in order, for future inventory work on the islands.

1. General collections on Santa Barbara Island. With only 4 herbarium specimens and one puzzling unvouchered report (Carter, 2015), this island is the least well known. It also has the lowest probability of interesting finds outside of east Anacapa Island, but the lack of any real baseline is problematic.
2. General collections on San Miguel Island. The soils and vegetation on San Miguel Island do not appear to be particularly promising bryophyte habitat, but the low number of collections, especially outside Cuyler Harbor, prevents any real floristic analysis of the island.
3. Focused collecting in the soil crusts across the islands. All of the large islands, and perhaps some of the smaller ones as well, have remnants of intact soil crust that were probably widespread in coastal southern California prior to conversion to anthropogenic landscapes. The bryophyte components of these communities are very inconspicuous and there may be undocumented diversity in these habitats. Included in this general category would be targeted surveys for the rare *Geothallus tuberosus*, especially on Santa Catalina and San Clemente Islands.
4. Focused collecting in the upper elevation and north facing slopes of Santa Cruz and Santa Rosa Islands. There are a number of biogeographically interesting species that occur from only a collection or two from these sites. These apparently relictual sites rely on heavy fog drip and are likely to be quite vulnerable to any climatic changes that reduce fog cover on the north islands. See Carter (2015) for further discussion.
5. Focused collecting in the steep eastern gorges on San Clemente Island. Some of the most interesting finds on San Clemente Island have come from these gorges, and it seems likely based on the summary in Table 2 that more species are present in these gorges.
6. General collections throughout the archipelago. Redundancy and collecting intensity are low across the islands, suggesting that documentation of bryophyte diversity remains in the relatively early stages.

VI. Works Cited

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VII. Tables & Figures

	Mosses	Liverworts	Hornworts	Totals
Anacapa	26	5	0	31
Santa Barbara	6	0	0	6
Santa Cruz	93	20	2	115
Santa Rosa	87	13	0	100
San Miguel	15	1	0	16
Santa Catalina	96	17	3	122
San Clemente	59	9	1	69
San Nicolas	35	7	0	42
Totals	156	29	4	

Table 1. Summary of the the number of mosses, liverworts and hornworts known from the Channel Islands

	Island Records	Island Richness	1 km cells	Empty 1km cells	% empty cells	Mean records/ cell*	Mean richness/ cell*	Mean Redundancy*
Anacapa	59	31	14	12	85.7	29.5	17.0	0.36
Santa Cruz	660	115	313	268	85.6	14.7	10.1	0.16
Santa Rosa	487	100	263	233	88.6	16.2	11.2	0.22
San Miguel	37	16	61	55	90.2	6.2	3.7	0.13
Santa Catalina	782	122	250	173	69.2	10.2	7.9	0.13
San Clemente	341	69	198	175	88.4	14.8	9.4	0.26
San Nicolas	268	42	81	48	59.3	8.1	5.6	0.24
Totals	1180	189	2627	967	81.9	12.3	8.7	0.181

Table 2. Summary of spatial collecting effort based on 1km grid cells. Santa Barbara is not included because there are no georeferenced specimens. Redundancy is calculated as 1-(Richnesss/ Number of collections) for each cell. Calculations with an asterisk (*) included only cells for which there was at least one collection.

Absent from Santa Cruz	**Absent from Santa Rosa**
Gemmabryum dichotomum *Microbryum starckeanum*	*Homalothecium aeneum* *Rosulabryum gemmascens* *Grimmia pulvinata* *Didymodon rigidulus* *Stegonia hyalinotricha* *Syntrichia papillosa* *Tortula acaulon* *Tortula guepinii* *Fossombronia longiseta* *Riccia trichocarpa* *Phaeoceros pearsonii*
Absent from Santa Catalina	**Absent from San Clemente**
Scleropodium cespitans *Scleropodium occidentale*	*Rosulabryum capillare* *Rosulabryum torquescens* *Pleuridium acuminatum* *Isothecium stoloniferum* *Claopodium whippleanum* *Epipterygium tozeri* *Orthotrichum coulteri* *Orthotrichum franciscanum* *Polytrichum juniperinum* *Aloina ambigua* *Pseudocrossidium crinitum* *Syntrichia laevipila* *Timmiella crassinervis* *Cephaloziella divaricata* *Frullania bolanderi* *Marsupella bolanderi* *Sphaerocarpos texanus*

Table 3. Species present on three of the four large islands (Santa Cruz, Santa Rosa, Santa Catalina, San Clemente) but so far not recorded on the fourth.

Absent from Anacapa	Absent from Santa Cruz
Rosulabryum capillare *Rosulabryum torquescens* *Funaria hygrometrica* *Orthotrichum papillosum* *Aloina ambigua* *Aloina bifrons* *Didymodon australasiae* *Didymodon tophaceus*	None
Absent from Santa Rosa	**Absent from San Miguel**
None	*Anacolia baueri* *Scleropodium julaceum* *Gemmabryum gemmiferum* *Gemmabryum kunzei* *Gemmabryum violaceum* *Fissidens sublimbatus* *Entosthodon bolanderi* *Funaria muhlenbergii* *Grimmia laevigata* *Grimmia trichophylla* *Alsia californica* *Bestia longipes* *Nogopterium gracile* *Orthotrichum franciscanum* *Syntrichia princeps* *Tortula atrovirens* *Tortula californica* *Weissia controversa* *Asterella californica* *Frullania bolanderi* *Frullania catalinae* *Riccia nigrella*

Table 4. Species present on three of the four north islands (Santa Cruz, Santa Rosa, San Miguel, Anacapa) but so far not recorded on the fourth.

Absent from Santa Catalina	Absent from San Clemente
None	None
Absent from San Nicolas	**Absent from Santa Barbara**
Didymodon rigidulus *Syntrichia ruralis*	*Scleropodium californicum* *Bryum argenteum* *Gemmabryum dichotomum* *Gemmabryum gemmilucens* *Ceratodon purpureus* *Fissidens crispus* *Fissidens sublimbatus* *Entosthodon bolanderi* *Funaria hygrometrica* *Aloina bifrons* *Didymodon australasiae* *Didymodon brachyphyllus* *Didymodon tophaceus* *Stegonia hyalinotricha* *Tortula acaulon* *Tortula atrovirens* *Tortula brevipes* *Tortula guepinii* *Weissia controversa* *Asterella californica* *Fossombronia longiseta* *Riccia nigrella* *Riccia trichocarpa* *Targionia hypophylla*

Table 5. Species present on three of the four south islands (Santa Catalina, San Clemente, San Nicolas, Santa Barbara) but so far not recorded on the fourth.

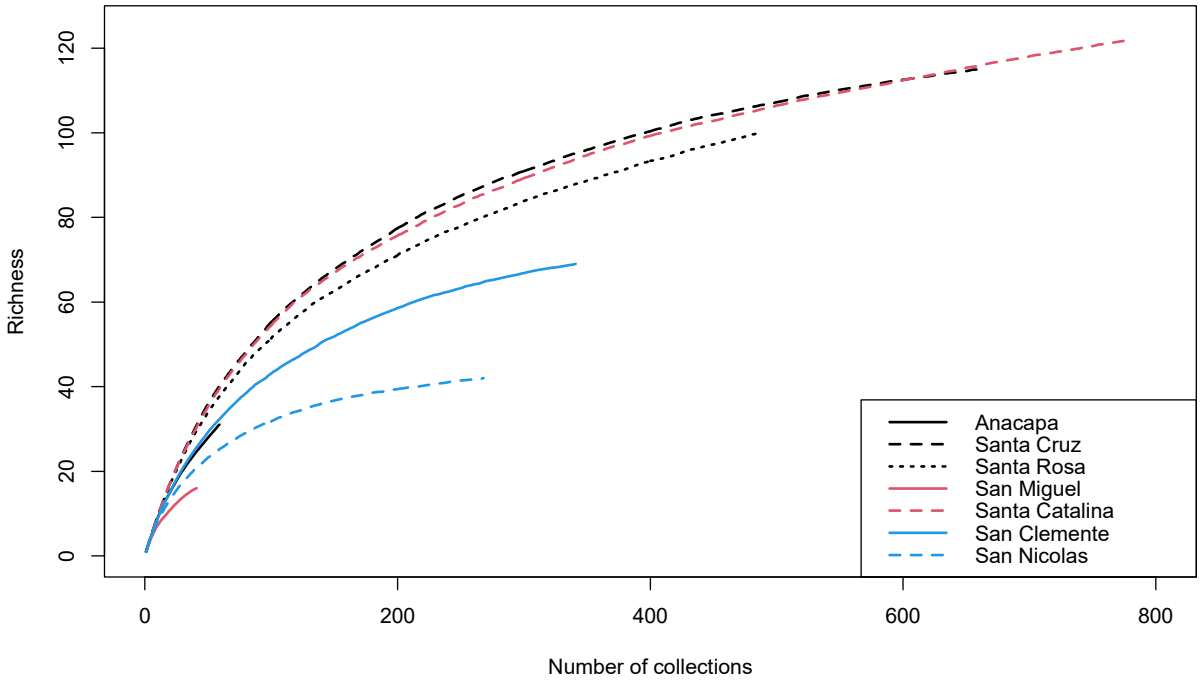

Figure 1. Species Accumulation Curves for the Channel Islands. Each Curve represents the average species accumulation for 100 randomizations of all specimens from the island. Santa Barbara, which has 6 known species from 6 collections, is not included in the figure.

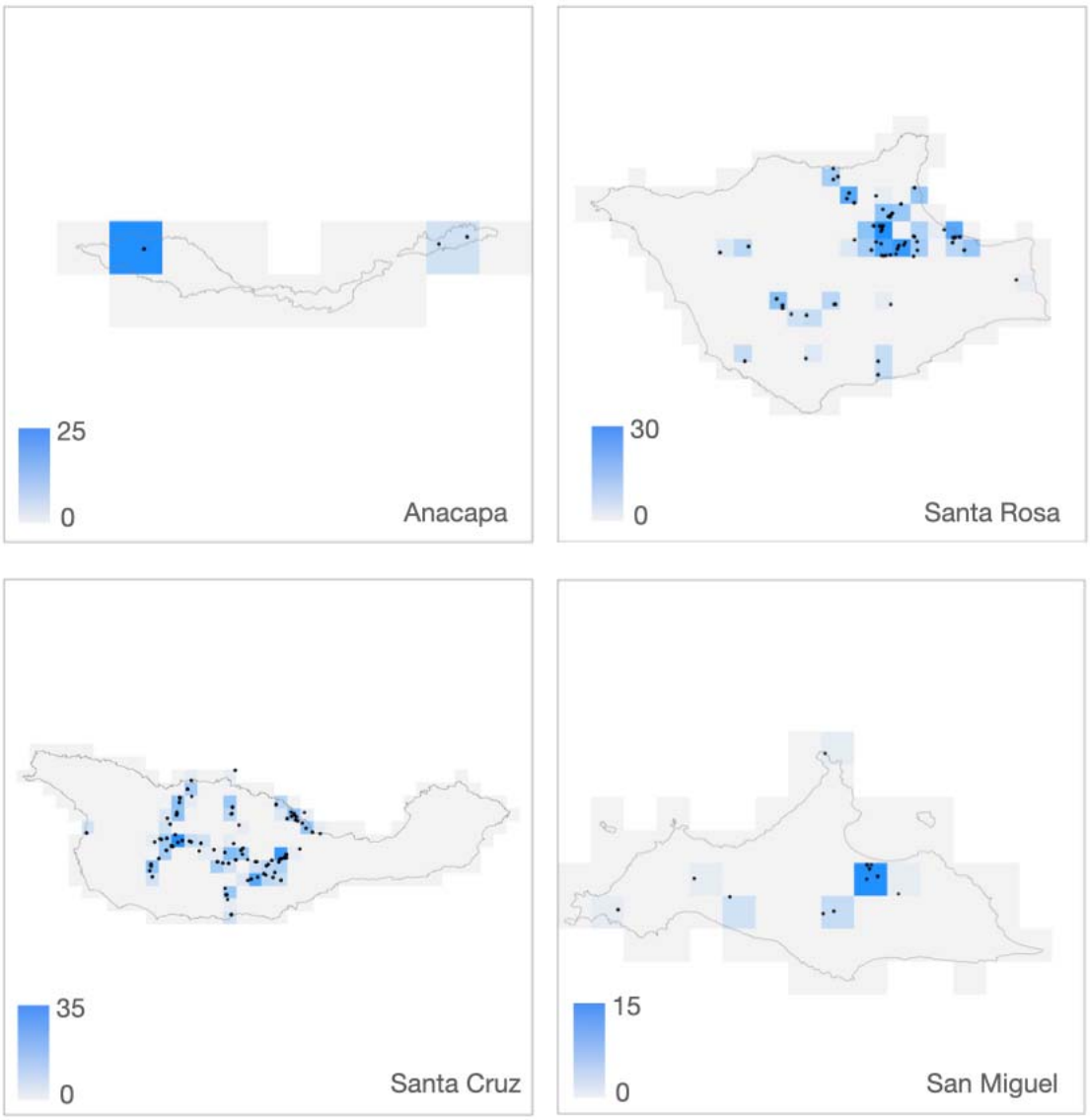

Figure 2. Collecting intensity on the north islands. Color intensity indicates number of collections per square kilometer. Dots indicate specific collecting localities. Note that both color intensity and spatial scale differ among island panels.

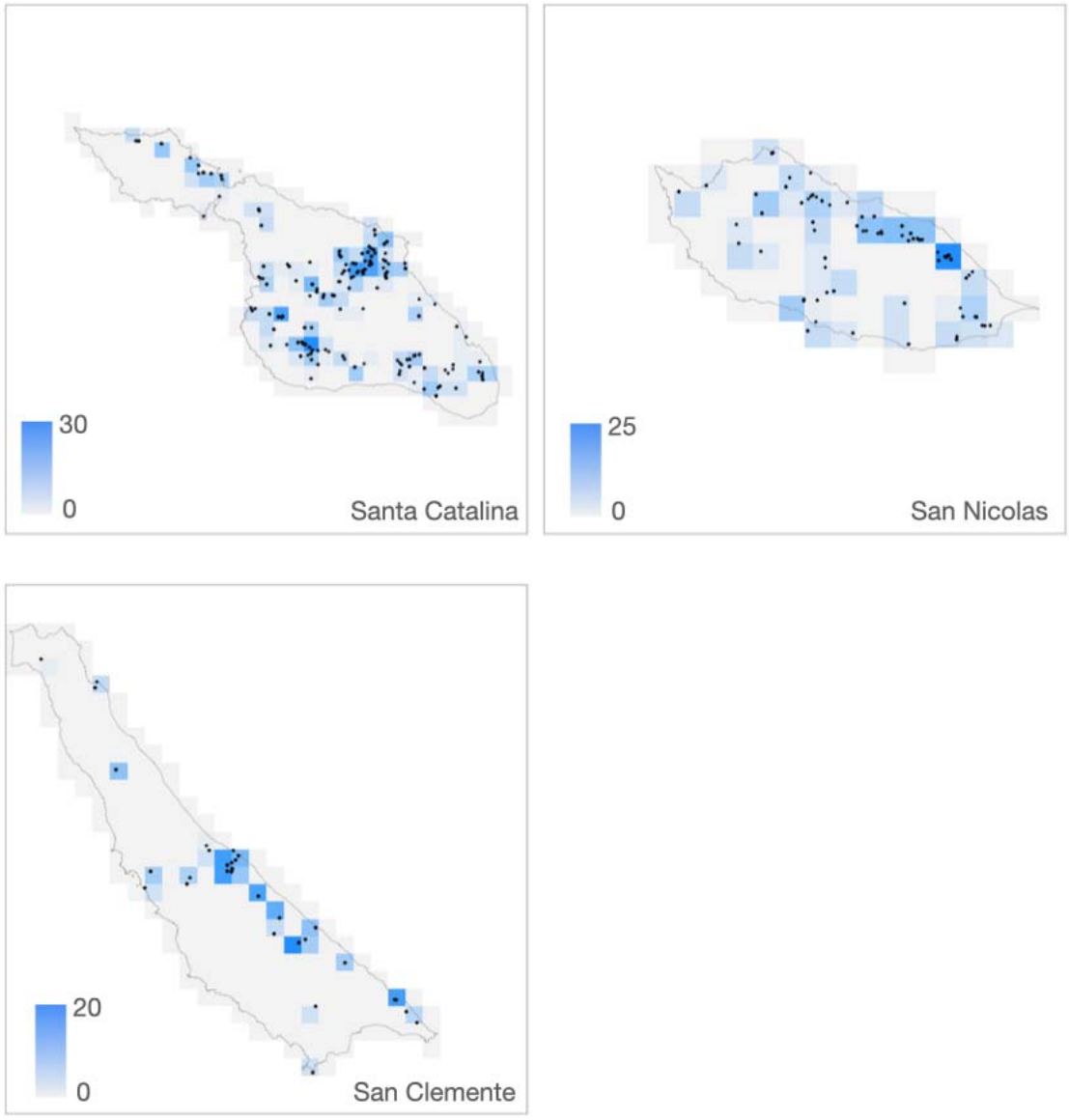

Figure 3. Collecting intensity on the south islands. Color intensity indicates number of collections per square kilometer. Dots indicate specific collecting localities. Note that both color intensity and spatial scale differ among island panels. Santa Barbara does not have any georeferenced specimens and is excluded.

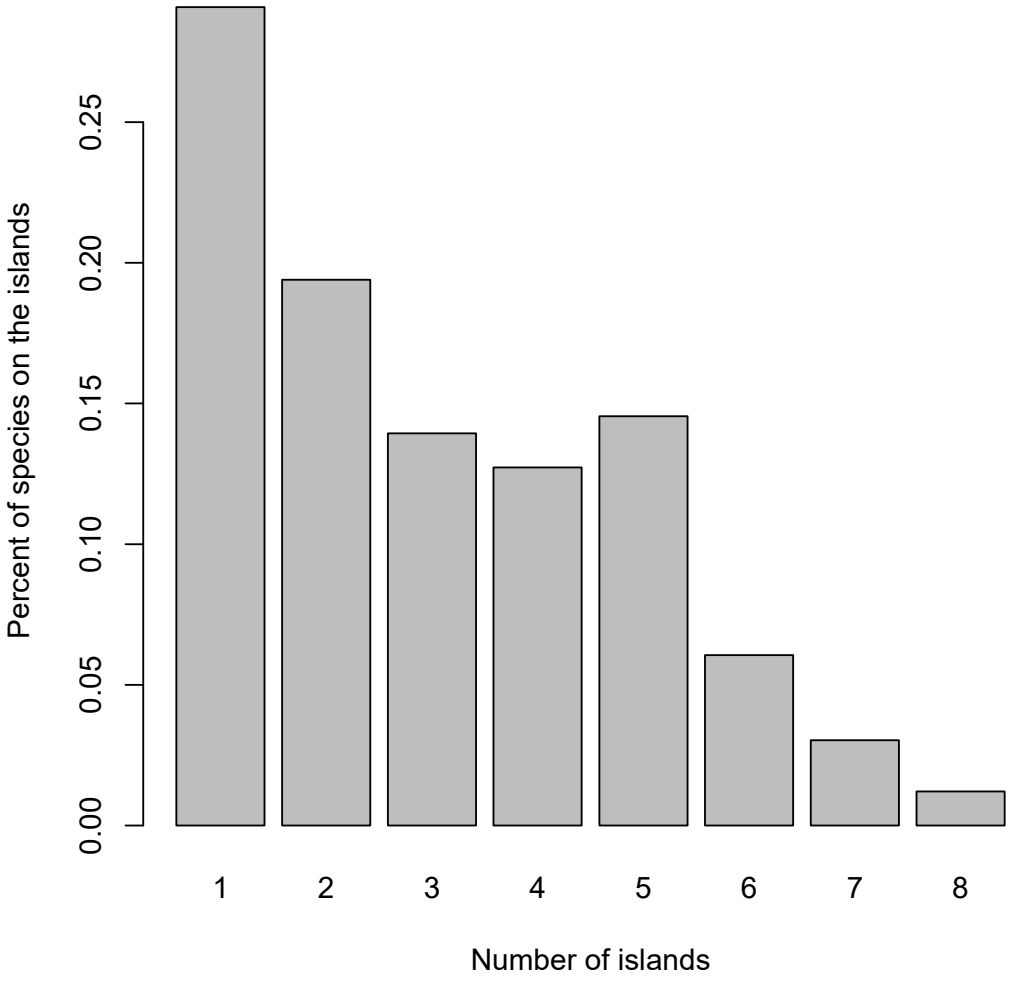

Figure 4. Distribution across islands. Each bar indicates the proportion of all bryophyte species (N=189) on the islands that are known to occur on exactly that number of islands.

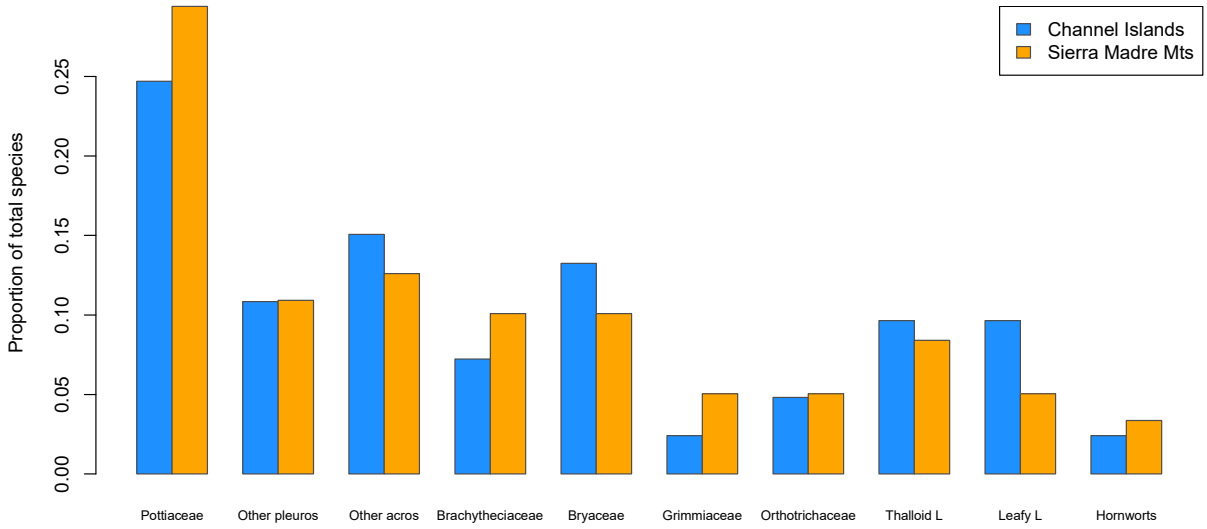

Figure 5. Comparison of major bryophyte taxa between the Channel Islands and Santa Monica Mountains. Other Pleuros includes all pleurocarpous mosses except those in the Brachytheciaceae. Other Acros includes all acrocarpous mosses except those in the Pottiaceae, Grimmiaceae, Bryaceae and Orthotrichaceae. Thalloid L and Leafy L refer to thalloid and leafy liverworts, respectively.

VIII. Appendices

Appendix 1. Updates to the published Channel Island Bryophytes checklist (Carter 2015).

Species	Island	Voucher or citation
Conardia compacta	SRo:	Shevock 20801 (CAS)
Bartramia aprica	SCz:	Carter 6748 (UC)
Bryum argenteum	SNi:	Carter et al., 2018
Gemmabryum barnesii	SRo:	Shevock 20883 (CAS)
Gemmabryum caespiticium	SCl:	Carter 5667 (UC)
Gemmabryum dichotomum	SNi:	Carter et al., 2018
Gemmabryum gemmilucens	SNi:	Carter et al., 2018
Gemmabryum radiculosum	SNi:	Carter et al., 2018
Gemmabryum valparaisense	SNi:	Carter 10656 (SJSU)
Gemmabryum vinosum	SRo:	Carter 6231a (UC)
Imbribryum muel/michro-	SCz:	checklist says muel, cnbh says micro
Ptychostomum creberrimum	SNi:	Carter et al., 2018
Rosulabryum canariense	SNi:	Carter et al., 2018
Rosulabryum capillare	SNi:	Carter et al., 2018
Rosulabryum gemmascens	SCl:	Carter 5725 (SJSU)
Homalothecium arenarium	SNi:	Carter et al., 2018
Ditrichum schimperi	SRo:	Shevock 20902 (CAS)
Fissidens crispus	SNi:	Carter et al., 2018
Fissidens curvatus	SNi:	Carter et al., 2018
Fissidens sublimbatus	SNi:	Carter et al., 2018
Funaria hygrometrica	SNi:	Carter 10661 (SJSU)
Hedwigia stellata	SCl:	Carter 6626 (UC)
Isothecium stoloniferum	SCa:	Carter 6968 (UC)
Antitrichia californica	SCl:	Carter 6639, 6612 (UC)
Orthotrichum norrisii	SCl:	Carter 6628a (SJSU)
Polytrichum piliferum	SRo:	Norris 102247 (UC)
Aloina ambigua	SNi:	Carter et al., 2018
Aloina bifrons	SNi:	Carter 10708 (SJSU);
	SRo:	Norris 102368 (UC)
Bryoerythrophyllum recurvirostrum	SCa:	Carter 6925, 5874 (UC)
Crossidium crassinervium	SCl:	Carter 8422,8417 (SJSU)
Gymnostomum viridulum	SNi:	Carter 10703 (SJSU)
Hennediella stanfordensis	SNi:	Carter et al., 2018
Microbryum starckeanum	SRo:	Shevock 20882 (CAS)
Pseudocrossidium obtusulum	SNi:	Carter 10652 (SJSU)
Stegonia hyalinotricha	SNi:	Carter 10692 (SJSU)
Syntrichia bartramii	SCz:	Carter 5272, 5410 (UC)
Syntrichia laevipila	SRo:	Shevock 20827 (CAS)
Syntrichia montana	SCa:	Millspaugh 4881,4887 (Field Museum);
	SRo:	Shevock 20781,20897,20761 (CAS)
Syntrichia sucrosa	SRo:	Carter 6199 (SJSU)
Timmiella crassinervis	SNi:	Carter et al., 2018
Tortella humilis	SNi:	Carter, 2017
Tortula acaulon	SNi:	Carter et al., 2018
Tortula atrovirens	SNi:	Carter et al., 2018
Tortula guepinii	SNi:	Carter et al., 2018
Weissia controversa	SNi:	Carter et al., 2018

Asterella californica	SNi:	Carter et al., 2018
Asterella bolanderi	SNi:	Carter et al., 2018
Riccia nigrella	SNi:	Carter 10640 (SJSU)
Riccia sorocarpa	SRo:	Norris 102188 (UC)
Riccia trichocarpa	SNi:	Carter 10641 (SJSU)
Sphaerocarpos texanus	SNi:	Carter 10643 (SJSU)
Targionia hypophylla	SNi:	Carter et al., 2018
Phymatoceros bulbiculosus	SCa:	Carter 7180 (SJSU)

Appendix 2. Checklist of the Channel Island Bryophytes (see attached excel spreadsheet).