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Title: SOME MACROPHYTIC, INTERTIDAL ALGAL ASSOCIATIONS ON THE COAST OF OREGON

Abstract approved: Redacted for Privacy
Harry K. Phinney

Two sampling lines were established in the intertidal region at each of three geographically separate sites on the coast of Oregon. Each sampling line, which was positioned in the zone dominated by the brown alga *Hedophyllum sessile*, was one meter in height and extended 50 meters horizontally. Information was sought concerning primarily the possible biological dependence of one species on another or the biological exclusion of one species by another. Secondary information was gathered on the floristic differences at intra- and inter-site levels.

No examples of exclusion were established but two putative cases of dependence were detected. Considering the factors of observed occurrences and co-occurrences, as well as calculated coefficient of association values, biological dependency was suggested for the algal pairs *Ulva expansa* - *Ralfsia pacifica* and *Gigartina papillata* - *Endocladia muricata*.

The sampling lines at only one of the three sites differed greatly in the probability of chance distribution of species. However, large differences were noted among each of the sites.

All sites were surveyed and the exact location of sampling lines are noted on aerial photographs.

Some Macrophytic, Intertidal Algal Associations
on the Coast of Oregon

by

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Every time field data were collected my wife Pat was there with me. Her assistance in carrying equipment and surveying, and watching for those unexpected large ocean waves was invaluable. Many days her help was the deciding factor in my being able to complete the day's work before the return of the tide.

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SOME MACROPHYTIC, INTERTIDAL ALGAL ASSOCIATIONS ON THE COAST OF OREGON

INTRODUCTION

Object of the Study

Early naturalistic descriptions and drawings of the biotic features of coastal intertidal areas, as summarized by Southward (1958), depicted the plants and animals as occurring in distinctly recognizable bands or zones. These bands were described as extending horizontally and varying in depth vertically. Subsequent studies, as summarized by Chapman (1946, 1957), have reviewed the earlier works on a global scale, and it has been noted that within the intertidal area there is a telescoped expression of both physical and biotic factors which have also been recognized as modifiers of the distribution of the terrestrial biota. Within the relatively short vertical distance in the intertidal area, the factors of wind, water, sunlight, nutrient availability, and biotic interactions, which are also influential in the terrestrial environment, all interact. In addition, it was observed that the number and width of zones varies with substrate shape, slope, and degree and type of wave exposure.

Other works have indicated that, although intertidal zonation varies in details from locality to locality, there are world-wide repetitions of selected zones. Stephenson and Stephenson (1949) in

Europe, South Africa, and North America and Womersley and Edmonds in Australia (1952) formulated what they considered to be universal zonation schemes for rocky shorelines. These two schemes differed slightly with respect to the names given to some zones and to the positions of the boundaries.

The present study goes one step further by taking an associative survey horizontally through a zone dominantly occupied by the brown alga *Hedophyllum sessile*. The basis for the selection of this zone was two-fold. First, Doty (1946) had recognized in Oregon a zone just above the mean lower low water level (MLLW) in which *H. sessile* was one of the more conspicuous forms. Second, in the zone observed by this study, *H. sessile* was most common and establishment of sampling lines was facilitated by its use. Within this zone those readily identifiable macrophytic algal species which occur together, excluding known cases of parasitism and epiphytisism, are noted. The object was to determine whether patterns of clumping of two species or exclusion of one species by another occurs as a result of biological interaction. Thus, these studies were specifically designed in an attempt to show interspecific patterns of association or segregation.

Experimental Design

The study was designed so that one person could obtain most of the field data testing for patterns. The design also required each basic unit of study to be an entity so that additions or deletions would not affect the conclusions concerning any other single units, although additions would assist in the comparisons of two or more units. The larger the total number of units the greater the possibility of making inter-unit comparisons. This flexibility was necessary for it was not known at the outset how extensive an area could be studied in the time available.

The basic study unit selected was a 50-meter horizontal sampling line. The sampling line was divided into 50 one-meter quadrats. Each quadrat was subdivided into four 0.25-meter segments. Within each quarter-meter segment, presence or absence data were noted for all species under consideration. The field study was conducted between June, 1970, and September, 1970.

Area Selection and Description of Sites

Accessible *Hedophyllum sessile* zones were sought that appeared to be as uniform in substrate surface and exposure as could be found. This was essential to make uniform, as far as possible, all physical factors affecting the distribution of plants within that zone. Such uniformity was expected to accentuate the effects of biotic factors. The study areas were to be at least one meter wide and 50 meters long in a straight or nearly straight path. The sample areas or sampling lines also had to be located in a distance accessible from the author's summer residence at Newport, Lincoln County, Oregon.

Three sites were located that possessed the desired characteristics. They were :

(1) The well protected cove immediately south of the Yaquina Head lighthouse at Agate Beach, Lincoln County, Oregon (Site Number One). This site is 4.8 km north of Newport, Oregon, and the available beach is approximately 400 meters in length. Generally surf action is light during the summer.

(2) Study Site Number Two was Boiler Bay, located immediately north of the Boiler Bay Wayside, Lincoln County, Oregon. Boiler Bay is 2 km north of the town of Depoe Bay, and 22.8 km north of Newport, Oregon. Boiler Bay consists of a series of small coves facing the open sea. Surf action is often heavy even on windless days.

(3) Study Site Number Three was about 400 meters south of Strawberry Hill, Neptune State Park, Lane County, Oregon. Strawberry Hill is 43.4 km south of Newport, Oregon. This site has a long, flat, rocky beach which is generally calm during summer months.

The sampling lines at Sites One and Two were adjacent to deep water which supports beds of Nereocystis luetkeana (Mertens) Postels and Ruprecht. All three study sites possess quite diverse floras and faunas. In all cases the substrates are of volcanic origin but at Site

Three the rock substrate tends to become partially buried by sand during the latter part of the summer.

MATERIALS AND METHODS

Site Preparation

Once the sites had been selected, both the number of sampling lines necessary and their locations were determined. In order to detect any differences among sites and to increase the total number of sampling lines, it was considered desirable to establish two 50-meter lines at each site, if time would permit. In order to permanently locate sampling lines, steel end stakes were installed. A hand-held star drill was utilized to make holes in the basalt substrate. Original plans called for 30-cm stakes to be buried to a depth of 15 cm. But few rocks withstood the force required to produce the holes, and most of the stakes were sunk 5-10 cm into holes at the base of narrow cracks. Then the entire area around the stake was filled with molten sulphur. All stakes remained in place, at least to the conclusion of the surveying period.

Site Mapping

Each site was surveyed to locate all reference stakes, including any intermediate and both terminal stakes for each sampling line. Angles and distances were noted from established bench marks or reference points. On the aerial photograph of each study site, the designation of reference stakes is preceded by an R, sampling line stakes by an S, and the angles by letters (see Plates I, II, and III).

Yaquina Head

R1 is the aerial on top of the Yaquina Head lighthouse. R2, originally marked by an embedded eye-bolt, is the bordering corner on the seaward edge of the rocky outcropping pictured.

Boiler Bay

R1 is a USCGS Bench Mark named "Bald 1927," elevation 52.890 feet, located in Boiler Bay Wayside. R2 is called the New Reference Point (NRP) and is a large eye-bolt near the edge of the rock pictured.

Strawberry Hill

R1 is the center of a picnic table (not pictured due to its emplacement subsequent to the taking of the photograph). R2 is the highest point on the most prominent rock formation 358 meters from R1. R3 is the highest point in its area. Originally, eye-bolts were set to mark R2 and R3.

Sampling Procedure

A rapid survey of each site was made to provide a list of species constituting the bulk of the biomass at each site. Combining the lists

Plate I. Aerial photograph of Study Site Number One at Yaquina Head, Agate Beach, Lincoln County, Oregon. Survey locating sampling lines which are indicated by solid, straight lines.

From point to point	Distance (meters)
S1-S2	25
S2-S3	25
S4-S5	50
R1-R2	298
R2-S1	85
R2-S2	62.5
R2-S3	37.5
R2-S4	7.5
R2-S5	60

Angle	Degrees
A	18.7
B	12.7
C	10.2
D	145.8
E	137.4

Elevation of stakes above mean low tide (meters)	
S1	+0.245
S2	-0.015
S3	-0.018
S4	-0.274
S5	-0.156

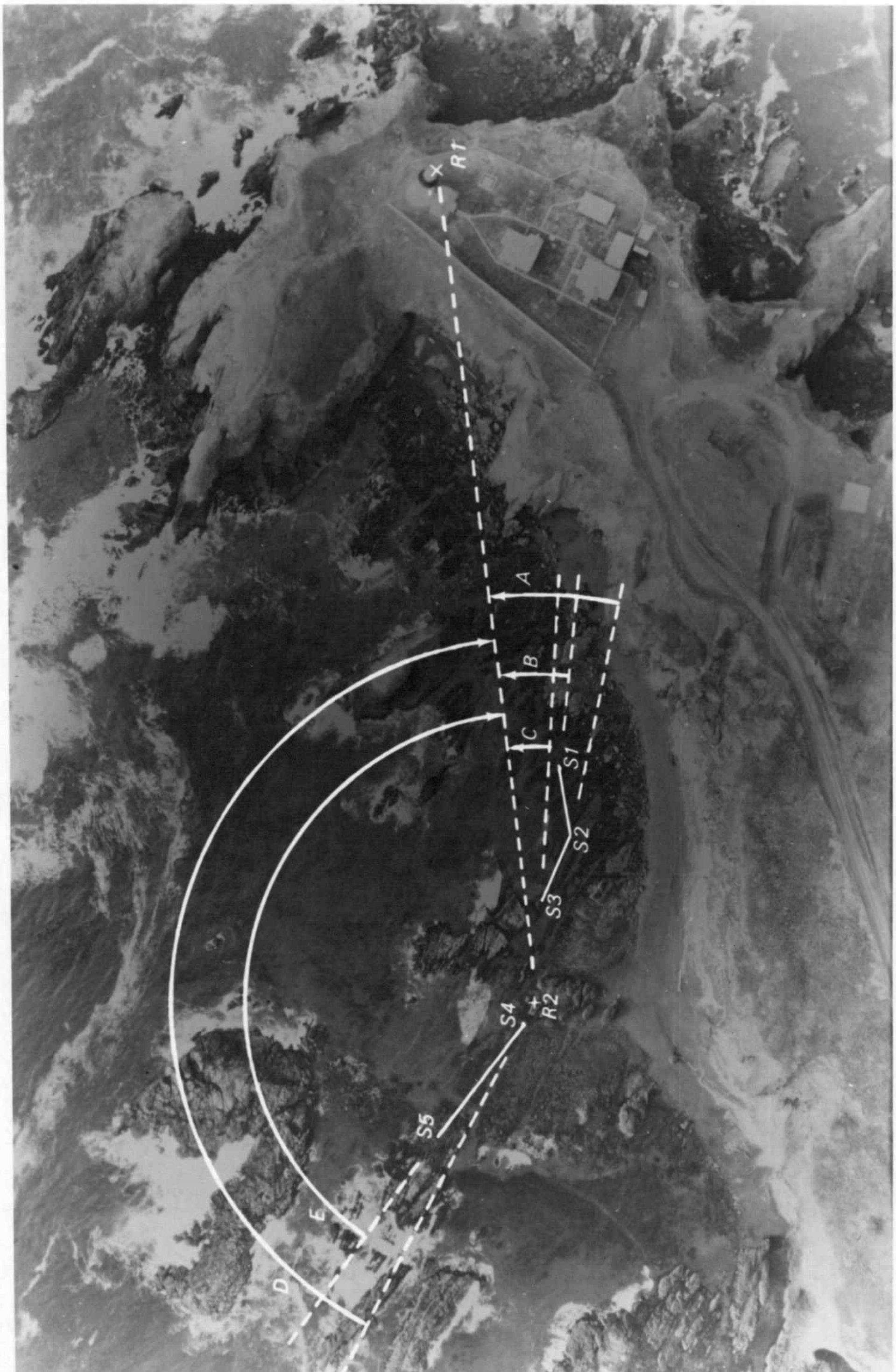

R1
A
B
C
S1
S2
S3
S4
R2
S5
D
E

Plate II. Aerial photograph of Study Site Number Two at Boiler Bay, immediately north of the Boiler Bay Wayside, Lincoln County, Oregon. Survey locating sampling lines which are indicated by solid, straight lines.

From point to point	Distance (meters)
S1-S2	50
S3-S4	50
R1-R2	490
R2-S1	82.5
R2-S2	132.5
R2-S3	10
R2-S4	62.5

Angle	Degrees
A	47.8
B	51
C	35.8
D	44.5

Elevation of stakes above mean low tide (meters)	
S1	+0.055
S2	+1.07
S3	+0.702
S4	+0.869

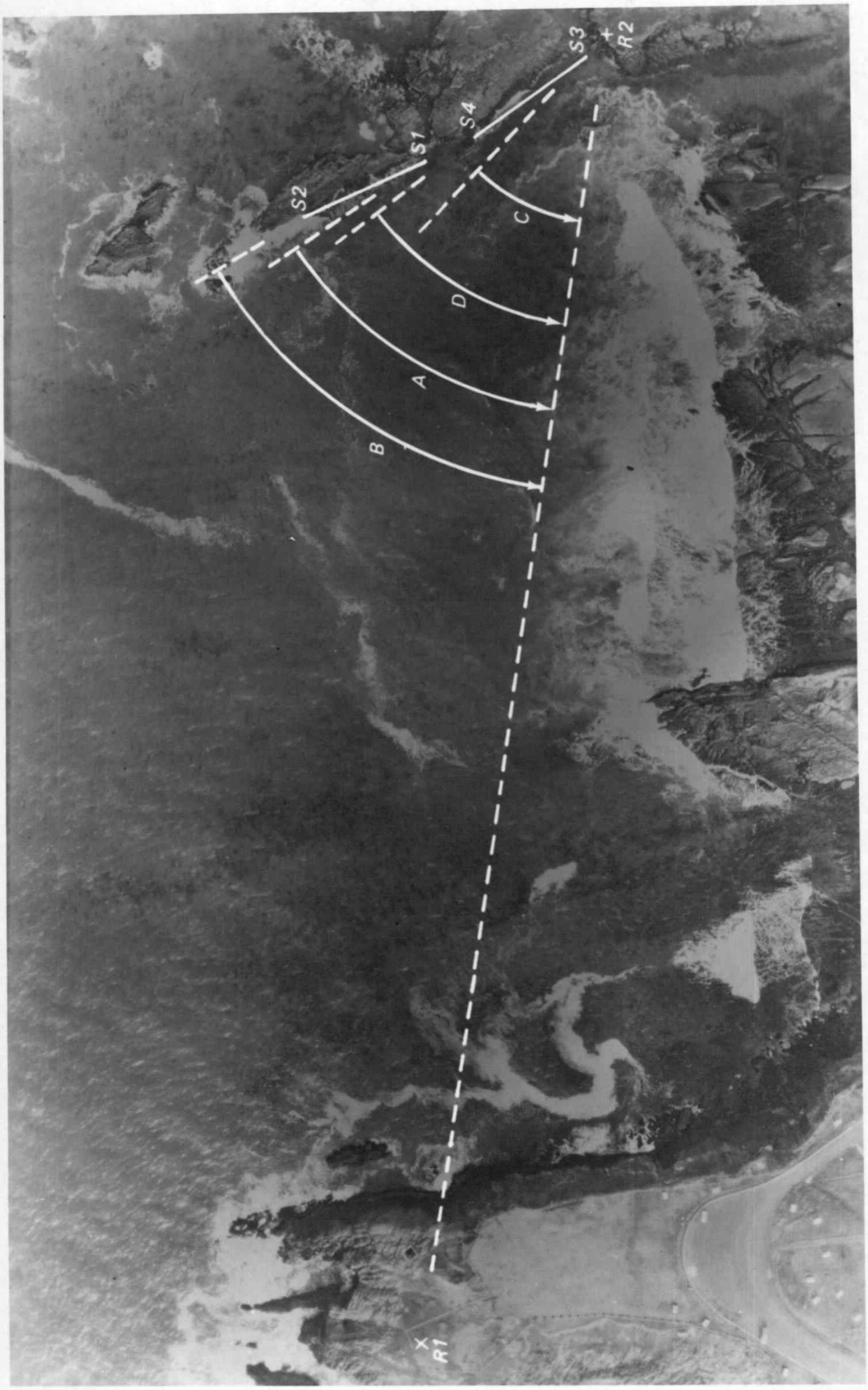
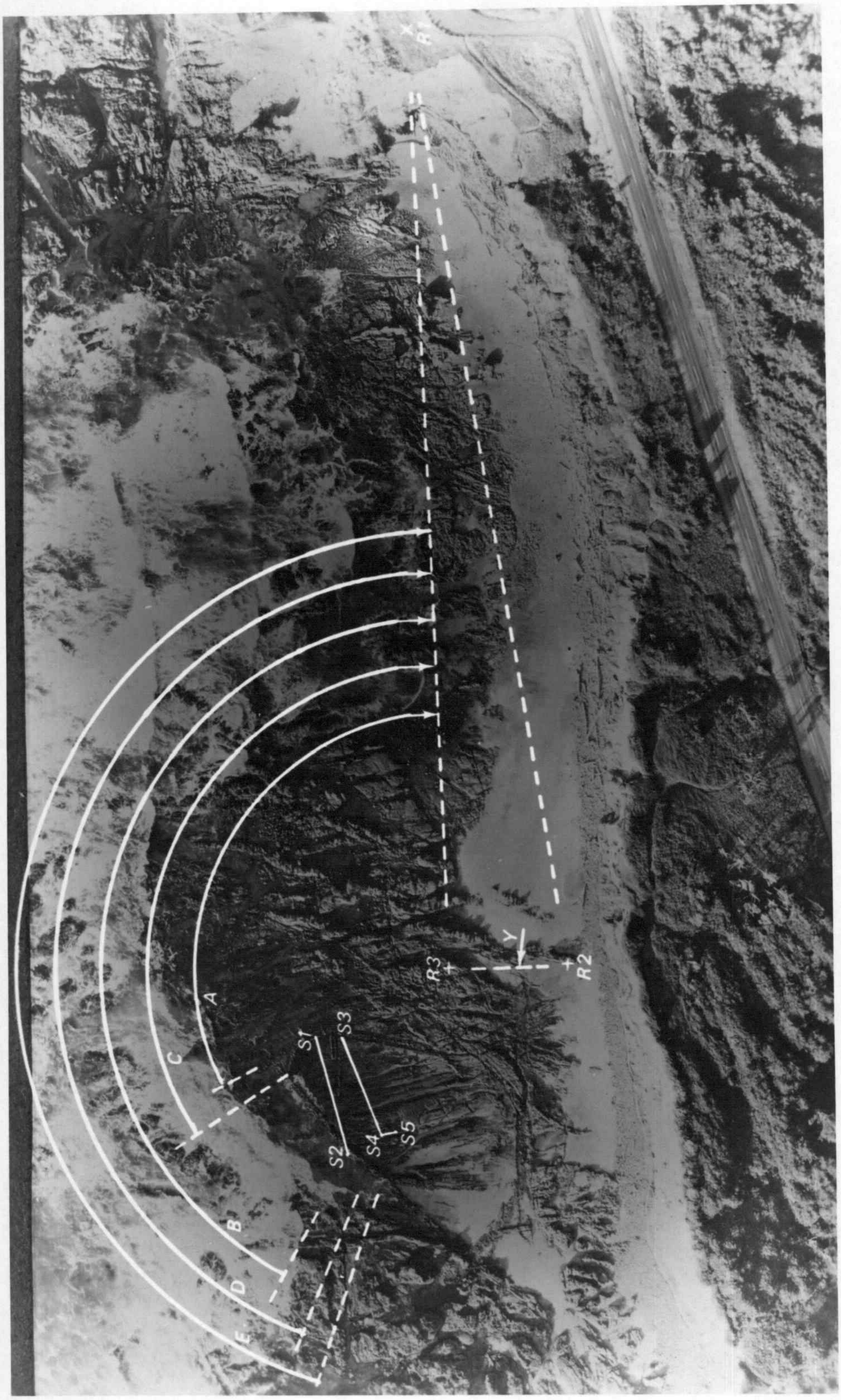

S2
S1
S4
S3
R2
B
A
D
C
R1

Plate III. Aerial photograph of Study Site Number Three at Strawberry Hill, Neptune State Park, Lane County, Oregon. Survey locating sampling lines which are indicated by solid, straight lines.

From point to point	Distance (meters)
S1-S2	50
S3-S4	40
S4-S5	10
R1-R2	360
R1-R3	358
R2-R3	45
R3-S1	57.5
R3-S2	82.5
R3-S3	50
R3-S4	70
R3-S5	67.5

Angle	Degrees
A	115
B	149.1
C	120.9
D	155.3
E	159.7
Y	82.3

Elevation of stakes above mean low tide (meters)	
S1	+0.406
S2	+0.336
S3	+0.378
S4	+0.338
S5	+0.342


A
B
C
D
E
S1
S2
S3
S4
S5
R2
R3
X
Y

from each of the sites produced a list of species that constituted 95+% of the total biomass. Next, a detailed survey, recording presence and absence data, was made of the first ten meters of Sampling Line Number One at Yaquina Head to determine the time that would be involved in making the complete survey. By consulting appropriate tide tables and weather reports from previous years, the probable number of available working days in the field was determined. Based on the size and number of study areas, the time necessary to survey each study area, and the total time available, it was concluded that both sampling lines at all three sites could be surveyed before the arrival of the autumn storms and the consequent foul weather. As the field study was being completed, the first Pacific storm arrived early but it appeared and dissipated between two low tide periods.

For ease in recording data in the field, species were assigned a number (Table 1). A first page of the data tabulation chart is reproduced in Appendix I. On this chart, species numbers are at the top and bottom of each page. On the left margin, each quadrat with its accompanying four segments is listed.

Table 1. The macrophytic, intertidal, algal species involved in the association study.

Chlorophyta	
1.	*Cladophora trichotoma* (C. A. Agardh) Kützing
2.	*Spongomorpha coalita* (Ruprecht) Collins
3.	*Ulva expansa* (Setchell) Setchell and Gardner
Phaeophyta	
4.	*Alaria marginata* Postels and Ruprecht
5.	*Egregia menziesii* (Turner) Areschoug
6.	*Hedophyllum sessile* (C. A. Agardh) Setchell
7.	*Laminaria sinclairii* (Harvey) Farlow
8.	*Leathesia difformis* (Linnaeus) Areschoug
9.	*Lessoniopsis littoralis* (Farlow and Setchell) Reinke
10.	*Ralfsia pacifica* Hollenberg in Smith
Rhodophyta	
11.	*Bossiella frondescens* (Postels and Ruprecht) Dawson
12.	*Callithamnion pikeanum* Harvey
13.	*Corallina vancouveriensis* Yendo
14.	*Dilsea californica* (J. G. Agardh) O. Kuntze
15.	*Endocladia muricata* (Postels and Ruprecht) J. G. Agardh
16.	*Gigartina cristata* (Setchell) Setchell and Gardner
17.	*Gigartina papillata* (C. A. Agardh) J. G. Agardh
18.	*Gymnogongrus linearis* (Turner) J. G. Agardh
19.	*Halosaccion glandiforme* (Gmelin) Ruprecht
20.	*Hymenena multiloba* (J. G. Agardh) Kylin
21.	*Iridaea flaccida* (Setchell and Gardner) Hollenberg and Abbott
22.	*Iridaea heterocarpum* Postels and Ruprecht
23.	*Iridaea splendens* (Setchell and Gardner) Papenfuss
24.	*Laurencia spectabilis* Postels and Ruprecht
25.	*Lithophyllum* sp.
26.	*Microcladia borealis* Ruprecht
27.	*Odonthalia floccosa* (Esper) Falkenberg
28.	*Odonthalia washingtoniensis* Kylin
29.	*Plocamium pacificum* Kylin
30.	*Polysiphonia hendryi* Gardner
31.	*Porphyra lanceolata* (Setchell and Hus) Smith
32.	*Rhodomela larix* (Turner) C. A. Agardh

MATHEMATICAL METHODS OF DATA ANALYSIS

Coefficients of co-occurrence were determined to establish the existence of association or segregation of any two species. These coefficients, which were calculated by the procedure presented below, assumed a random distribution of species within each segment.

For all 32 species, both O_i and $O_{i,j}$ were tabulated where:

O_i = the number of segments in which the i-th species was observed;

$O_{i,j}$ = the number of segments in which both the i-th species and the j-th species were observed to occur together.

To determine the probable occurrence of each species considered separately, P_i is calculated. It is given by

$$P_i = \frac{O_i}{N}$$

where N = total number of segments sampled.

For the probability of the co-occurrence of the i-th species with the j-th species

$$P_{i,j} = P_i P_j$$

where the values for i and j range from 1 to 32.

The expected value of the co-occurrence of the i-th species with the j-th species is given by

$$E_{i,j} = N\, P_{i,j}$$

Knowing both the observed and the expected values for the species pairings, chi-square, χ^2, is calculated.

$$\chi^2 = \sum_{1}^{496} \frac{(O_{i,j} - E_{i,j})^2}{E_{i,j}}$$

Here, considering 496 degrees of freedom and viewing the resulting χ^2 values, relative departures from randomness can be noted. While this is not a specific indicator of which species may be causing the departures, it surely is a parameter to show differences or similarities both within sites and between two or more sites.

For the purpose of this study, the most meaningful expression of the relationship between any two species is the coefficient of association ($A_{i,j}$). It is

$$A_{i,j} = \frac{O_{i,j} - E_{i,j}}{E_{i,j}}$$

This equation is sensitive to species which occur occasionally as well as to those of frequent occurrence. This common scaling is accomplished by dividing by the expected values. Were it not for this feature, some high correlations would probably be noted due to frequent occurrences alone.

Positive coefficients of association which indicate positive associations will have a theoretical upper limit of approximately 1, 200. The larger the positive number the greater the departure from randomness, in the direction of biologically based positive association. Coefficients of association of zero indicate random association and are not significant for the purpose of this study.

Negative values are generated if there is either biologically based exclusion or exclusion due to the presence of some unfavorable physical factor(s). The former could result from either the presence of some dominant antagonist or the absence of some obligatory symbiont. Negative coefficients of association (segregation values) will have a lower limit of -1. Although in the lower limit the greatest segregation occurs, the degree of such segregation is lost. For such cases of segregation only the expected value of the co-occurrence of the i-th species with the j-th species is meaningful and should be used. The cause of the -1 lower limit is the non-pairing of two particular species. Thus, the coefficient of association for this pair is the observed value, zero, minus the expected value, all divided by the expected value and such cases the answer will always be -1.

Even though values of the probability of the occurrence of species in pairs become important in indicating associative patterns, when the coefficients of association are -1, the probability of co-occurrence based on random distribution must exceed certain levels before significance can be established. For the purpose of this work and within the parameters just described, a lower limit of 0.500 is set for the values of the probability of the occurrence of species in pairs. Thus, all pairs of species whose coefficients of association are -1 and whose probabilities of co-occurrence fail to reach 0.500 will be considered insignificant and will be disregarded.

RESULTS

Species That Were Considered

Thirty-two species were tested for co-occurrence in this study (Table 1). Of the 16 more conspicuous species found by Doty (1946) in this same intertidal zone (Table 2), six appear in common. In addition, in the two lists, *Gigartina*, *Laurencia*, and *Ulva* differ only in the species name used. *Iridaea* and *Iridophycus* are the same plants and *Dilsea californica* and *Rhodoglossum affine* are so close in form that they might be confused. *Gelidium coulteri* and *Postelsia palmaeformis* were not seen in this study and, although *Egregia menziesii* was observed, it occurred primarily lower in the intertidal than was studied. In summary, it can be stated that most of the algal forms listed by Doty were included in this study.

Scope of Analysis

All mathematical calculations indicated above (p. 13-14) were performed in their entirety ten separate times in this work. First, each of the six sampling lines was analyzed individually. The data then were composited for each of the three sites and the sites were then analyzed individually. Finally, all data were composited and analyzed, for a total of ten analyses. The observed occurrence and co-occurrence plus the expected co-occurrence and chi-square values for

Table 2. The more conspicuous species found by Doty (1946) which occur in the same intertidal zone examined in this study.

Corallina sp.
Egregia menziesii (Turner) Areschoug
Gelidium coulteri Harvey
Gigartina canaliculata Harvey
Gigartina leptorhynchos J. G. Agardh
Halosaccion glandiforme (Gmelin) Ruprecht
Hedophyllum sessile (C. A. Agardh) Setchell
Iridophycus (Iridaea) splendens (Setchell and Gardner) Papenfuss
Laurencia crispa Hollenberg
Laurencia pacifica Kylin
Leathesia difformis (Linnaeus) Areschoug
Odonthalia floccosa (Esper) Falkenberg
Postelsia palmaeformis Ruprecht
Rhodoglossum affine (Harvey) Kylin
Rhodomela larix (Turner) C. A. Agardh
Ulva lobata (Kützing) Setchell and Gardner

all ten analyses are included in Appendix II.

Occurrence of Species

The 32 species considered have been ranked according to their frequency of occurrence (Table 3). The number of other species with which a particular species is paired, and the general range, as observed in the field, of each species was also determined.

Positive Coefficients of Association

In view of the effort to remove the effects of differences in physical factors for both intra- and inter-site location, it is assumed that all positive co-occurrences of species is due to some biological dependence. Keeping this assumption in mind and noting the positive values of the coefficients of associations, the largest values must represent the greatest dependence. For the purpose of this study, all values $\geq$ 3.00 will be considered significant. The range of values calculated from all ten sets of data is 0.00 to 31.14 (Table 4).

Negative Coefficients of Association

In none of the ten sets of calculations did any combination of species have a -1 coefficient of association and at the same time have a probability of co-occurrence exceeding the previously established lower limit of 0.500. Thus, while segregation of some pairs of

Table 3. The 32 algal species considered, ranked according to total abundance.

Abundance (composite)	Species	No. of species with which it co-occurs significantly	Range: zone studied and; above	below
701	Hedophyllum sessile	0	N/A	N/A
620	Rhodomela larix	0	x	
543	Lithophyllum sp.	3	x	x
530	Ulva expansa	1		x
496	Odonthalia floccosa	4		x
467	Iridaea splendens	0		x
424	Bossiella frondescens	2		x
386	Dilsea californica	2	x	
342	Ralfsia pacifica	6	x	
272	Gigartina papillata	4	x	
244	Egregia menziesii	0		x
225	Endocladia muricata	6	x	
180	Corallina vancouveriensis	6	x	x
175	Hymenena multiloba	2		x
175	Alaria marginata	2		x
149	Microcladia borealis	9	x	
128	Porphyra lanceolata	3	x	
107	Iridaea heterocarpum	4	x	
106	Iridaea flaccida	3	x	
92	Cladophora trichotoma	3	x	
91	Polysiphonia hendryi	4		x
78	Laurencia spectabilis	8		x
62	Gigartina cristata	1	x	
53	Lessoniopsis littoralis	3		x
42	Spongomorpha coalita	6		x
38	Odonthalia washingtoniensis	3		x
37	Callithamnion pikeanum	12	x	
35	Halosaccion glandiforme	5	x	
31	Gymnogongrus linearis	2	x	
31	Laminaria sinclairii	5		x
16	Leathesia difformis	8	x	
7	Plocamium pacificum	8		x

Table 4. Range of the positive significant coefficient of association values for the areas indicated.

Coefficient of association	Species
	Site Number One - Yaquina Head
(a) Sampling line Number One	
24.00	Leathesia difformis, Halosaccion glandiforme
4.00	Callithamnion pikeanum, Corallina vancouveriensis
3.17	Spongomorpha coalita, Corallina vancouveriensis
3.17	Halosaccion glandiforme, Porphyra lanceolata
(b) Sampling line Number Two	
9.53	Laurencia spectabilis, Microcladia borealis
9.00	Spongomorpha coalita, Laurencia spectabilis
4.13	Gigartina papillata, Laurencia spectabilis
(b) Sampling lines Number One and Two combined	
11.90	Leathesia difformis, Halosaccion glandiforme
11.50	Spongomorpha coalita, Laurencia spectabilis
9.26	Laurencia spectabilis, Microcladia borealis
9.00	Callithamnion pikeanum, Corallina vancouveriensis
3.04	Leathesia difformis, Gigartina papillata
3.04	Gigartina papillata, Laurencia spectabilis
	Site Number Two - Boiler Bay
(a) Sampling line Number One	
21.22	Gigartina papillata, Polysiphonia hendryi
3.55	Alaria marginata, Halosaccion glandiforme
3.08	Ulva expansa, Ralfsia pacifica
(b) Sampling line Number Two	
25.67	Cladophora trichotoma, Odonthalia washingtoniensis
9.00	Spongomorpha coalita, Iridaea flaccida
9.00	Callithamnion pikeanum, Iridaea flaccida
9.00	Laurencia spectabilis, Odonthalia washingtoniensis
7.33	Spongomorpha coalita, Halosaccion glandiforme
4.41	Endocladia muricata, Gigartina papillata
4.00	Endocladia muricata, Polysiphonia hendryi
3.44	Cladophora trichotoma, Iridaea heterocarpum

(Continued on next page)

Table 4. (Continued)

Coefficient of association	Species
(c) Sampling lines Number One and Two combined	
11.50	Spongomorpha coalita, Halosaccion glandiforme
11.50	Spongomorpha coalita, Iridaea flaccida
11.50	Callithamnion pikeanum, Iridaea flaccida
9.00	Endocladia muricata, Gigartina papillata
8.30	Endocladia muricata, Polysiphonia hendryi
6.02	Cladophora trichotoma, Iridaea heterocarpum
6.02	Cladophora trichotoma, Odonthalia washingtoniensis
5.20	Cladophora trichotoma, Polysiphonia hendryi
4.43	Callithamnion pikeanum, Polysiphonia hendryi
3.17	Spongomorpha coalita, Callithamnion pikeanum
	Site Number Three - Strawberry Hill
(a) Sampling line Number One	
12.33	Callithamnion pikeanum, Endocladia muricata
11.50	Callithamnion pikeanum, Corallina vancouveriensis
11.50	Corallina vancouveriensis, Microcladia borealis
10.11	Ralfsia pacifica, Callithamnion pikeanum
10.11	Ralfsia pacifica, Microcladia borealis
8.09	Laminaria sinclairii, Laurencia spectabilis
8.09	Laminaria sinclairii, Porphyra lanceolata
6.69	Iridaea flaccida, Microcladia borealis
6.41	Ralfsia pacifica, Endocladia muricata
5.67	Endocladia muricata, Microcladia borealis
5.67	Endocladia muricata, Plocamium pacificum
5.25	Ralfsia pacifica, Corallina vancouveriensis
5.25	Gymnogongrus linearis, Iridaea heterocarpum
5.25	Corallina vancouveriensis, Plocamium pacificum
4.56	Ralfsia pacifica, Plocamium pacificum
4.26	Spongomorpha coalita, Dilsea californica
4.26	Callithamnion pikeanum, Dilsea californica
3.88	Lithophyllum sp., Microcladia borealis
3.88	Lithophyllum sp., Porphyra lanceolata
(b) Sampling line Number Two	
15.67	Callithamnion pikeanum, Microcladia borealis
15.67	Corallina vancouveriensis, Microcladia borealis
15.67	Callithamnion pikeanum, Odonthalia floccosa

(Continued on next page)

Table 4. (Continued)

Coefficient of association	Species
Sampling line Number Two (continued)	
12.33	*Leathesia difformis, Callithamnion pikeanum*
12.33	*Laminaria sinclairii, Laurencia spectabilis*
9.26	*Ralfsia pacifica, Microcladia borealis*
7.89	*Leathesia difformis, Microcladia borealis*
7.33	*Leathesia difformis, Corallina vancouveriensis*
7.00	*Leathesia difformis, Plocamium pacificum*
7.00	*Laurencia spectabilis, Plocamium pacificum*
6.69	*Ralfsia pacifica, Callithamnion pikeanum*
6.41	*Microcladia borealis, Odonthalia floccosa*
6.14	*Callithamnion pikeanum, Lithophyllum* sp.
5.35	*Lithophyllum* sp., *Microcladia borealis*
5.25	*Callithamnion pikeanum, Corallina vancouveriensis*
4.56	*Alaria marginata, Laminaria sinclairii*
3.57	*Bossiella frondescens, Plocamium pacificum*
3.44	*Laminaria sinclairii, Gymnogongrus linearis*
3.44	*Leathesia difformis, Odonthalia floccosa*
3.44	*Laminaria sinclairii, Plocamium pacificum*
3.44	*Odonthalia floccosa, Plocamium pacificum*
3.29	*Bossiella frondescens, Callithamnion pikeanum*
(c) Sampling lines Number One and Two combined	
20.33	*Leathesia difformis, Callithamnion pikeanum*
15.00	*Callithamnion pikeanum, Microcladia borealis*
12.33	*Corallina vancouveriensis, Microcladia borealis*
11.90	*Laminaria sinclairii, Porphyra lanceolata*
10.43	*Leathesia difformis, Plocamium pacificum*
9.67	*Leathesia difformis, Microcladia borealis*
9.32	*Ralfsia pacifica, Microcladia borealis*
8.22	*Laminaria sinclairii, Laurencia spectabilis*
7.16	*Laurencia spectabilis, Plocamium pacificum*
6.74	*Ralfsia pacifica, Callithamnion pikeanum*
5.67	*Callithamnion pikeanum, Corallina vancouveriensis*
5.67	*Callithamnion pikeanum, Odonthalia floccosa*
5.45	*Lithophyllum* sp., *Porphyra lanceolata*
5.21	*Ralfsia pacifica, Endocladia muricata*
5.15	*Iridaea flaccida, Microcladia borealis*
4.91	*Ralfsia pacifica, Corallina vancouveriensis*
4.56	*Leathesia difformis, Corallina vancouveriensis*
4.33	*Leathesia difformis, Iridaea heterocarpum*

(Continued on next page)

Table 4. (Continued)

Coefficient of association	Species
Sampling lines Number One and Two combined (continued)	
4.16	*Lithophyllum* sp., *Microcladia borealis*
3.44	*Microcladia borealis*, *Odonthalia floccosa*
3.00	*Spongomorpha coalita*, *Dilsea californica*
3.00	*Callithamnion pikeanum*, *Dilsea californica*
	Sites Number One, Two, and Three combined
31.14	*Leathesia difformis*, *Plocamium pacificum*
8.53	*Lessoniopsis littoralis*, *Odonthalia washingtoniensis*
7.74	*Laminaria sinclairii*, *Gymnogongrus linearis*
7.11	*Leathesia difformis*, *Callithamnion pikeanum*
5.97	*Lessoniopsis littoralis*, *Laurencia spectabilis*
4.62	*Halosaccion glandiforme*, *Porphyra lanceolata*
4.53	*Laminaria sinclairii*, *Plocamium pacificum*
4.43	*Lessoniopsis littoralis*, *Hymenena multiloba*
4.10	*Hymenena multiloba*, *Laurencia spectabilis*
3.45	*Laurencia spectabilis*, *Odonthalia washingtoniensis*
3.42	*Gigartina cristata*, *Halosaccion glandiforme*
3.28	*Callithamnion pikeanum*, *Iridaea flaccida*
3.28	*Callithamnion pikeanum*, *Polysiphonia hendryi*

species apparently occurred, the degree of segregation was insufficient to allow inference as to its probable reality.

ANALYSIS OF RESULTS

Intra-Site Comparisons

It must be kept in mind that not all 32 species under consideration appear at all three sites (Table 5). Within each site the average number of observations of a particular species does not vary much from one sampling line to another. The greatest intra-site difference occurred at Boiler Bay, where the chi-square values (Table 6) suggest that in the second sampling line the probability of chance distribution of species alone is smaller.

Table 5. The algal species which were found only at one site with their location.

Species	Yaquina Head	Boiler Bay	Strawberry Hill
Laminaria sinclairii			x
Lessoniopsis littoralis		x	
Gymnogongrus linearis			x
Hymenena multiloba		x	
Odonthalia washingtoniensis		x	
Plocamium pacificum			x
Gigartina cristata	x		

At Yaquina Head the pairs of species with the highest coefficients of association were Leathesia difformis - Halosaccion glandiforme (24.00) followed by Laurencia spectabilis - Microcladia borealis

Table 6. Chi-square values.

	x^2
<u>Site 1 - Yaquina Head</u>	
Sampling line 1	320.68
Sampling line 2	295.20
Sampling lines 1 and 2 combined	518.45
<u>Site 2 - Boiler Bay</u>	
Sampling line 1	286.56
Sampling line 2	690.97
Sampling lines 1 and 2 combined	1,535.98
<u>Site 3 - Strawberry Hill</u>	
Sampling line 1	566.02
Sampling line 2	669.76
Sample lines 1 and 2 combined	1,029.99
Sites 1, 2, and 3 combined	6,194.91

(9.53) and Laurencia spectabilis - Spongomorpha coalita (9.00). At this site, Laurencia spectabilis was paired significantly with three other entities.

At Boiler Bay the highest, and almost equal, coefficients of association were obtained for the pairs Cladophora trichotoma - Odonthalia washingtoniensis (25.67) and Gigartina papillata - Polysiphonia hendryi (21.22). At this site no species was paired significantly with more than two other entities.

At Strawberry Hill the coefficient of association between any two species was not much more significant than that between several other pairs of species. But, Leathesia difformis, Ralfsia pacifica, Callithamnion pikeanum, Microcladia borealis, and Plocamium pacificum were paired much more frequently than the remaining species.

Inter-Site Comparisons

The average occurrence of each species at Strawberry Hill is approximately 70% of the average of the other two sites (Table 7). Chi-square values (Table 6) indicate that the probability of distribution of species due to chance alone is least at Boiler Bay and greatest at Yaquina Head.

Considering the variation between sites, the species pair with the largest coefficient of association is Leathesia difformis -

Table 7. The abundance and average occurrence of the algal species at each sampling line and site.

	No. of species present	Average occurrence of each species
Site 1 - Yaquina Head		
Sampling line 1	22	51.63
Sampling line 2	23	58.39
Sampling lines 1 and 2 combined	26	95.34
Site 2 - Boiler Bay		
Sampling line 1	20	65.75
Sampling line 2	25	52.76
Sampling lines 1 and 2 combined	26	101.30
Site 3 - Strawberry Hill		
Sampling line 1	25	35.92
Sampling line 2	22	39.63
Sampling lines 1 and 2 combined	26	68.07
Sites 1, 2, and 3 combined	32	215.09

Callithamnion pikeanum. *C. pikeanum* is paired significantly with more species than any other entity.

Characterization of Associations Within the Zone

The dominant species of the zone characterize the zone and their presence is an indication of the tidal level being studied. Within the zone studied, *Hedophyllum sessile*, *Rhodomela larix*, *Lithophyllum* sp., *Ulva expansa*, *Odonthalia floccosa*, and *Iridaea splendens* were the six most abundant species and comprised 48.77% of the total number of times that all species were observed.

In order to gain a better understanding of the relationships between species within the zone, it was considered helpful to construct a schematic diagram of the species associations. In this diagram, consideration was given to both the researcher's intuitive knowledge of the arrangement of species and to the mathematical results obtained from the field data collected (Figure 1). Not all of the coefficients of association listed in Table 4 above were considered. Only those pairs of species which were paired together in the composite sample three or more times or which were paired together twice with one of the pairings having a coefficient of association value of ≥ 9.00 were considered. The strengths of the associations are determined by the number of pairings which are indicated by the numbers placed beside the interconnecting lines.

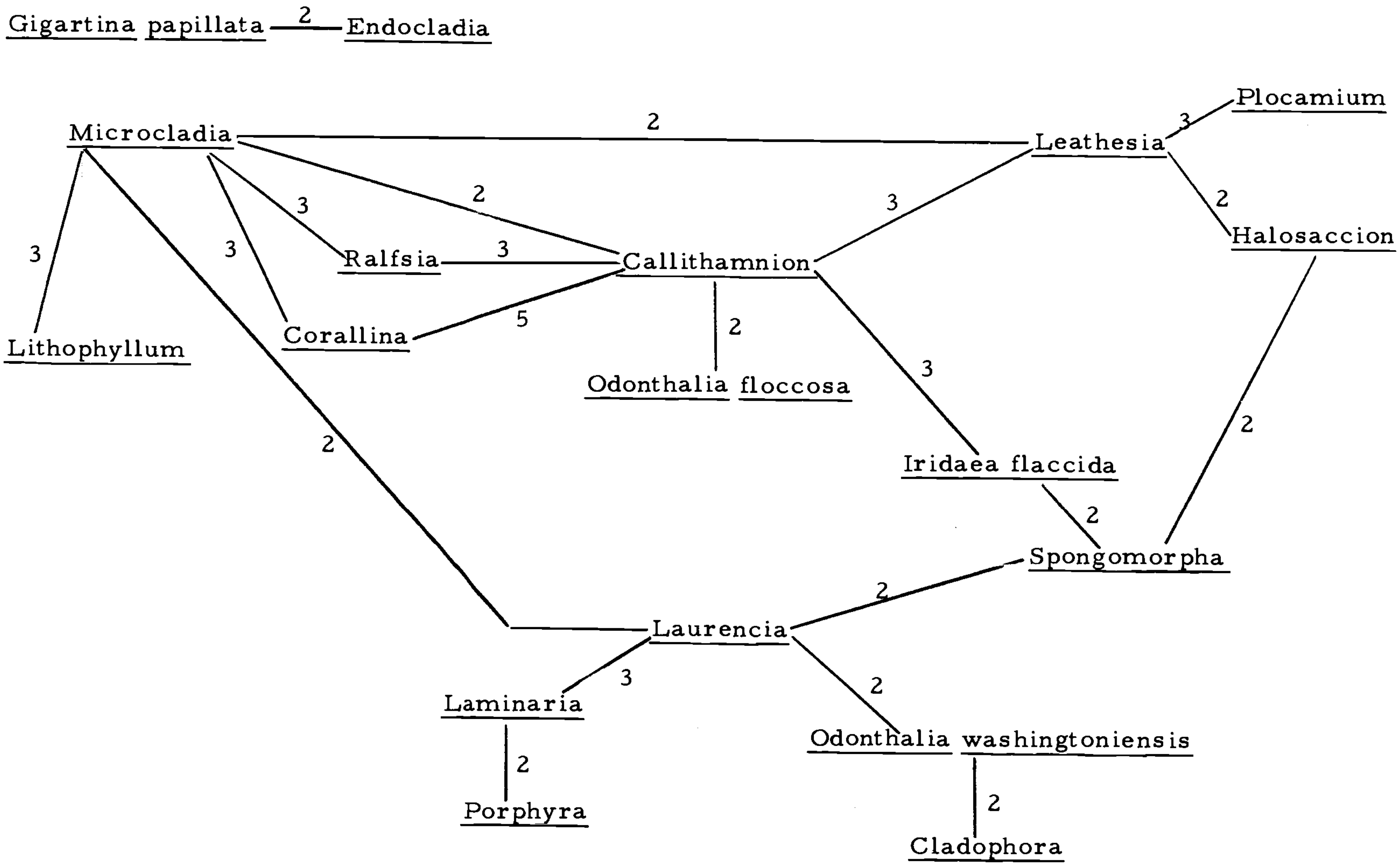


Figure 1. Schematic representation of the vegetational associations of the most prominent species based upon coefficients of association obtained from composite data. An approximate representation of the vertical algal zonation is indicated by the positioning of the species from the top to the bottom of this diagram.

A high coefficient of association was obtained when two species were low in occurrence but yet by chance were found together. This situation occurred especially for species endemic to one location or site. The coefficient of association values obtained in this manner are misleading and fail to indicate true relationships. Also, when evaluating the composite figures, allowances were not made for exclusions based on differences due to characteristics of the different sites. Erroneous relationships appear as a result as in the cases of Laminaria sinclairii and Porphyra lanceolata which occurred essentially at different sites as do Odonthalia washingtoniensis and Cladophora trichotoma (Figure 1). Thus, the high coefficient of association values obtained for these species pairs are misleading. Both Callithamnion pikeanum and Microcladia borealis appear throughout the zone at all three sites and are paired significantly with more different species than any of the remaining species.

To correct this situation, in addition to the coefficient of associations, the number and location of occurrences must also be considered. Keeping this in mind, six combinations of occurrences and co-occurrences can potentially yield useful insights. Four of these combinations (Table 8) can potentially yield meaningful relationships.

Considering all observations together, the pairs Ulva expansa-Ralfsia pacifica and Gigartina papillata - Endocladia muricata, both

Table 8. The six possible combinations of occurrence and co-occurrence values to produce association relationships.

Case number	Relative occurrence of the first species	Relative occurrence of the second species	Relative co-occurrence size	Potential yield of a meaningful relationship
1	large (≥ 200)	large (≥ 200)	large (≥ 200)	yes
2	large (≥ 200)	large (≥ 200)	small (< 200)	yes
3	large (≥ 200)	small (< 200)	relatively large (≥ 100)	yes
4	large (≥ 200)	small (< 200)	minimal (< 100)	no
5	small (< 200)	small (< 200)	relatively large (≥ 100)	yes
6	small (< 200)	small (< 200)	minimal (< 100)	no

of which appear as Case 2 of Table 8, show the greatest associations. These pairings indicate the most positive cases of inter-species dependency.

DISCUSSION

With the type of data available and the method of analysis utilized, two types of information were obtained from this study. The first type allowed us to attempt to answer the original question of whether there appeared to be patterns of association or segregation among littoral algal species. Here correlation values of co-occurrences are tested for significance. The second type of information is related to the first type but is a necessary bonus. Here we found the intra- and inter-site differences that sometimes help to explain the true significance of correlation coefficients. An hypothesis of intra-site similarity and a prior knowledge of geographical modifiers can be weighed for their merit.

As seen in Table 3, the distribution of many of the species considered tended to range either above or below the zone studied. This distributional spread included species of both frequent and rare occurrence. As a result of this spread, associational patterns were noticed in which the zone studied was linked with the areas above and below. Consequently, some of the associational patterns, Leathesia difformis - Halosaccion glandiforme for example, are not unique to just the zone dominated by Hedophyllum sessile.

Two pairs of species, Ulva expansa - Ralfsia pacifica and Gigartina papillata - Endocladia muricata, which were determined to be the most significantly associated, are found in the upper limits of the zone studied. Their high co-occurrence established the fact that the same physical conditions favor the growth and development of each. At the same time some type of biological relationship between the members of each pair is also suggested.

CONCLUSIONS

In this study the intra- and inter-site information as well as the information of algal co-occurrences are both meaningful. While biotic exclusion has been discounted, cases of biotic dependence are strongly suggested but not confirmed. The dominant species, as well as the more rarely appearing species, of the zone studied have been established.

It has been shown that there can be, and are, large differences of species occurrences within a single site. While geographical separation of sites can point to the fact of species diversity, sites can be consistent as to the associative nature of those species which are present.

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APPENDICES

APPENDIX I

First page of the field data tabulation chart. The numbers that were assigned to the species utilized are given at the top and bottom. On the left margin, each quadrat with its accompanying four segments is listed.

Dr. Harry K. Phinney

Gary L. Gill

Marine Algae Intertidal Survey

Boiler Bay #1
" #2

Yaquina Head #1
" #2

Strawberry Hill #1
" #2

________________, 1970-1971

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1A																																
B																																
C																																
D																																
2A																																
B																																
C																																
D																																
3A																																
B																																
C																																
D																																
4A																																
B																																
C																																
D																																
5A																																
B																																
C																																
D																																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

APPENDIX II

The observed occurrence and co-occurrence plus the expected co-occurrence and chi-square values for all ten mathematical analyses involving the 32 algal species under consideration.

Site Number One - Yaquina Head Sampling Line Number One

Total number of segments in which each individual species occurs (diagonal) and total number of segments in which any two species are found to occur together (remainder of matrix).

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	15																															
2	3	12																														
3	9	9	121																													
4	0	0	0	0																												
5	0	0	0	0	0																											
6	13	7	55	0	0	98																										
7	0	0	0	0	0	0	0																									
8	0	0	0	0	0	0	0	1																								
9	0	0	0	0	0	0	0	0	0																							
10	3	5	42	0	0	35	0	0	0	78																						
11	2	0	2	0	0	7	0	0	0	0	7																					
12	2	0	8	0	0	15	0	0	0	3	2	20																				
13	1	1	2	0	0	3	0	0	0	0	0	2	4																			
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0																		
15	5	2	63	0	0	64	0	1	0	45	3	12	1	0	115																	
16	5	0	16	0	0	10	0	0	0	8	1	3	0	0	18	25																
17	4	1	32	0	0	28	0	1	0	33	0	7	0	0	49	10	60															
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0														
19	0	1	5	0	0	3	0	1	0	3	0	0	0	0	6	1	3	0	8													
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0												
21	6	3	26	0	0	39	0	0	0	17	4	11	2	0	37	7	18	0	2	0	55											
22	7	2	24	0	0	29	0	0	0	20	2	6	1	0	31	13	22	0	1	0	22	47										
23	4	1	15	0	0	17	0	0	0	12	1	9	1	0	21	7	14	0	1	0	9	11	35									
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0								
25	8	7	87	0	0	53	0	0	0	44	3	10	2	0	58	12	26	0	2	0	26	20	13	0	118							
26	3	0	7	0	0	10	0	0	0	7	1	7	0	0	11	4	7	0	1	0	9	4	12	0	8	20						
27	11	11	88	0	0	66	0	1	0	50	7	16	3	0	70	12	37	0	5	0	43	26	26	0	85	15	138					
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
30	4	0	10	0	0	12	0	0	0	6	2	5	0	0	13	6	6	0	0	0	8	7	8	0	9	6	14	0	0	20		
31	2	2	12	0	0	6	0	0	0	7	0	0	0	0	5	2	2	0	2	0	1	3	1	0	7	0	8	0	0	0	12	
32	4	4	70	0	0	58	0	0	0	64	2	9	1	0	82	15	43	0	6	0	34	33	18	0	72	11	80	0	0	8	9	127

Site Number One - Yaquina Head   Sampling Line Number One

Observed value for the occurrence of each individual species and the expected values for the co-occurrence of any two species.*

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1 21	2 22	3 23	4 24	5 25	6 26	7 27	8 28	9 29	10 30	11 31	12 32	13	14	15	16	17	18	19	20
1	15.0																			
2	.9	12.0																		
3	9.1	7.3	121.0																	
4	0	0	0	0																
5	0	0	0	0	0															
6	7.3	5.9	59.3	0	0	98.0														
7	0	0	0	0	0	0	0													
8	.1	.1	.6	0	0	.5	0	1.0												
9	0	0	0	0	0	0	0	0	0											
10	5.8	4.7	47.2	0	0	38.2	0	.4	0	78.0										
11	.5	.4	4.2	0	0	3.4	0	.0	0	2.7	7.0									
12	1.5	1.2	12.1	0	0	9.8	0	.1	0	7.8	.7	20.0								
13	.3	.2	2.4	0	0	2.0	0	.0	0	1.6	.1	.4	4.0							
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
15	8.6	6.9	69.6	0	0	56.3	0	.6	0	44.8	4.0	11.5	2.3	0	115.0					
16	1.9	1.5	15.1	0	0	12.3	0	.1	0	9.8	.9	2.5	.5	0	14.4	25.0				
17	4.5	3.6	36.3	0	0	29.4	0	.3	0	23.4	2.1	6.0	1.2	0	34.5	7.5	60.0			
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
19	.6	.5	4.8	0	0	3.9	0	.0	0	3.1	.3	.8	.2	0	4.6	1.0	2.4	0	8.0	
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	4.1	3.3	33.3	0	0	27.0	0	.3	0	21.5	1.9	5.5	1.1	0	31.6	6.9	16.5	0	2.2	0
	55.0																			
22	3.5	2.8	28.4	0	0	23.0	0	.2	0	18.3	1.6	4.7	.9	0	27.0	5.9	14.1	0	1.9	0
	12.9	47.0																		
23	2.6	2.1	21.2	0	0	17.1	0	.2	0	13.6	1.2	3.5	.7	0	20.1	4.4	10.5	0	1.4	0
	9.6	8.2	35.0																	
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0																
25	8.8	7.1	71.4	0	0	57.8	0	.6	0	46.0	4.1	11.8	2.4	0	67.8	14.8	35.4	0	4.7	0
	32.5	27.7	20.6	0	118.0															
26	1.5	1.2	12.1	0	0	9.8	0	.1	0	7.8	.7	2.0	.4	0	11.5	2.5	6.0	0	.8	0
	5.5	4.7	3.5	0	11.8	20.0														
27	10.3	8.3	83.5	0	0	67.6	0	.7	0	53.8	4.8	13.8	2.8	0	79.3	17.3	41.4	0	5.5	0
	38.0	32.4	24.1	0	81.4	13.8	138.0													
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0												
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0											
30	1.5	1.2	12.1	0	0	9.8	0	.1	0	7.8	.7	2.0	.4	0	11.5	2.5	6.0	0	.8	0
	5.5	4.7	3.5	0	11.8	2.0	13.8	0	0	20.0										
31	.9	.7	7.3	0	0	5.9	0	.1	0	4.7	.4	1.2	.2	0	6.9	1.5	3.6	0	.5	0
	3.3	2.8	2.1	0	7.1	1.2	8.3	0	0	1.2	12.0									
32	9.5	7.6	76.8	0	0	62.2	0	.6	0	49.5	4.4	12.7	2.5	0	73.0	15.9	38.1	0	5.1	0
	34.9	29.8	22.2	0	74.9	12.7	87.6	0	0	12.7	7.6	127.0								

CHI-SQUARE- 320.68

*Directions for reading values from this table: When comparing any two species, the larger species number is found on the vertical matrix index. The smaller species number is found on the horizontal matrix index. Note that the horizontal index is truncated for species numbers larger than 20. Values for species 21-32 are read in columns 1-12 in the second line following the vertical index species number. As an example, the value expected for the co-occurrence of species numbers 25 and 27 is 81.4.

Site Number One - Yaquina Head — Sampling Line Number Two

Total number of segments in which each individual species occurs (diagonal) and total number of segments in which any two species are found to occur together (remainder of matrix).

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	58																															
2	6	20																														
3	54	16	162																													
4	7	1	10	12																												
5	9	4	24	3	30																											
6	48	18	115	8	25	148																										
7	0	0	0	0	0	0	0																									
8	0	0	0	0	0	0	0	0																								
9	0	0	0	0	0	0	0	0	0																							
10	28	4	82	1	12	79	0	0	0	100																						
11	1	1	4	1	2	6	0	0	0	4	6																					
12	0	0	0	0	0	0	0	0	0	0	0	0																				
13	0	0	0	0	0	0	0	0	0	0	0	0	0																			
14	4	3	11	0	3	14	0	0	0	11	0	0	0	15																		
15	21	4	66	0	6	53	0	0	0	40	3	0	0	9	82																	
16	12	3	28	0	2	22	0	0	0	21	0	0	0	2	28	37																
17	14	3	33	2	8	31	0	0	0	18	0	0	0	7	24	9	39															
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0														
19	9	1	22	0	2	13	0	0	0	9	1	0	0	3	15	7	4	0	23													
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0												
21	10	1	24	0	4	22	0	0	0	23	3	0	0	5	15	6	6	0	4	0	30											
22	11	3	24	0	4	25	0	0	0	17	0	0	0	7	18	5	9	0	5	0	6	31										
23	18	7	41	8	13	42	0	0	0	27	1	0	0	4	8	5	8	0	2	0	5	5	49									
24	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1								
25	35	13	84	11	13	71	0	0	0	53	2	0	0	5	30	18	12	0	8	0	11	13	32	0	99							
26	4	2	11	1	0	17	0	0	0	11	0	0	0	4	8	0	5	0	1	0	4	5	4	1	5	19						
27	39	12	101	10	15	96	0	0	0	78	2	0	0	7	42	23	22	0	7	0	17	19	42	1	71	10	122					
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
30	6	1	22	0	4	15	0	0	0	12	1	0	0	4	18	8	7	0	5	0	7	5	3	0	12	0	10	0	0	28		
31	31	13	97	3	17	84	0	0	0	46	3	0	0	6	48	21	24	0	19	0	15	20	21	1	49	10	56	0	0	17	115	
32	32	4	97	3	13	80	0	0	0	64	3	0	0	5	59	31	29	0	15	0	15	16	20	1	50	8	76	0	0	18	61	117

Site Number One - Yaquina Head   Sampling Line Number Two

Observed value for the occurrence of each individual species and the expected values for the co-occurrence of any two species.*

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1 21	2 22	3 23	4 24	5 25	6 26	7 27	8 28	9 29	10 30	11 31	12 32	13	14	15	16	17	18	19	20
1	58.0																			
2	5.8	20.0																		
3	47.0	16.2	162.0																	
4	3.5	1.2	9.7	12.0																
5	8.7	3.0	24.3	1.8	30.0															
6	42.9	14.8	119.9	8.9	22.2	148.0														
7	0	0	0	0	0	0	0													
8	0	0	0	0	0	0	0	0												
9	0	0	0	0	0	0	0	0	0											
10	29.0	10.0	81.0	6.0	15.0	74.0	0	0	0	100.0										
11	1.7	.6	4.9	.4	.9	4.4	0	0	0	3.0	6.0									
12	0	0	0	0	0	0	0	0	0	0	0	0								
13	0	0	0	0	0	0	0	0	0	0	0	0	0							
14	4.3	1.5	12.1	.9	2.2	11.1	0	0	0	7.5	.4	0	0	15.0						
15	23.8	8.2	66.4	4.9	12.3	60.7	0	0	0	41.0	2.5	0	0	6.2	82.0					
16	10.7	3.7	30.0	2.2	5.6	27.4	0	0	0	18.5	1.1	0	0	2.8	15.2	37.0				
17	11.3	3.9	31.6	2.3	5.8	28.9	0	0	0	19.5	1.2	0	0	2.9	16.0	7.2	39.0			
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
19	6.7	2.3	18.6	1.4	3.4	17.0	0	0	0	11.5	.7	0	0	1.7	9.4	4.3	4.5	0	23.0	
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	8.7	3.0	24.3	1.8	4.5	22.2	0	0	0	15.0	.9	0	0	2.2	12.3	5.6	5.8	0	3.4	0
	30.0																			
22	9.0	3.1	25.1	1.9	4.6	22.9	0	0	0	15.5	.9	0	0	2.3	12.7	5.7	6.0	0	3.6	0
	4.6	31.0																		
23	14.2	4.9	39.7	2.9	7.3	36.3	0	0	0	24.5	1.5	0	0	3.7	20.1	9.1	9.6	0	5.6	0
	7.3	7.6	49.0																	
24	.3	.1	.8	.1	.1	.7	0	0	0	.5	.0	0	0	.1	.4	.2	.2	0	.1	0
	.1	.2	.2	1.0																
25	28.7	9.9	80.2	5.9	14.9	73.3	0	0	0	49.5	3.0	0	0	7.4	40.6	18.3	19.3	0	11.4	0
	14.9	15.3	24.3	.5	99.0															
26	5.5	1.9	15.4	1.1	2.8	14.1	0	0	0	9.5	.6	0	0	1.4	7.8	3.5	3.7	0	2.2	0
	2.8	2.9	4.7	.1	9.4	19.0														
27	35.4	12.2	98.8	7.3	18.3	90.3	0	0	0	61.0	3.7	0	0	9.1	50.0	22.6	23.8	0	14.0	0
	18.3	18.9	29.9	.6	60.4	11.6	122.0													
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0												
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0											
30	8.1	2.8	22.7	1.7	4.2	20.7	0	0	0	14.0	.8	0	0	2.1	11.5	5.2	5.5	0	3.2	0
	4.2	4.3	6.9	.1	13.9	2.7	17.1	0	0	28.0										
31	33.3	11.5	93.2	6.9	17.2	85.1	0	0	0	57.5	3.4	0	0	8.6	47.2	21.3	22.4	0	13.2	0
	17.2	17.8	28.2	.6	56.9	10.9	70.2	0	0	16.1	115.0									
32	33.9	11.7	94.8	7.0	17.5	86.6	0	0	0	58.5	3.5	0	0	8.8	48.0	21.6	22.8	0	13.5	0
	17.5	18.1	28.7	.6	57.9	11.1	71.4	0	0	16.4	67.3	117.0								

CHI-SQUARE- 295.20

*Directions for reading values from this table: When comparing any two species, the larger species number is found on the vertical matrix index. The smaller species number is found on the horizontal matrix index. Note that the horizontal index is truncated for species numbers larger than 20. Values for species 21-32 are read in columns 1-12 in the second line following the vertical index species number. As an example, the value expected for the co-occurrence of species numbers 22 and 23 is 7.6.

Site Number One - Yaquina Head Sampling Lines Number One and Two Combined

Total number of segments in which each individual species occurs (diagonal) and total number of segments in which any two species are found to occur together (remainder of matrix).

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	73																															
2	9	32																														
3	63	25	283																													
4	7	1	10	12																												
5	9	4	24	3	30																											
6	61	25	170	8	25	246																										
7	0	0	0	0	0	0	0																									
8	0	0	0	0	0	0	0	1																								
9	0	0	0	0	0	0	0	0	0																							
10	31	9	124	1	12	114	0	0	0	178																						
11	3	1	6	1	2	13	0	0	0	4	13																					
12	2	0	8	0	0	15	0	0	0	3	2	20																				
13	1	1	2	0	0	3	0	0	0	0	0	2	4																			
14	4	3	11	0	3	14	0	0	0	11	0	0	0	15																		
15	26	6	129	0	6	117	0	1	0	85	6	12	1	9	197																	
16	17	3	44	0	2	32	0	0	0	29	1	3	0	2	46	62																
17	18	4	65	2	8	59	0	1	0	51	0	7	0	7	73	19	99															
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0														
19	9	2	27	0	2	16	0	1	0	12	1	0	0	3	21	8	7	0	31													
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0												
21	16	4	50	0	4	61	0	0	0	40	7	11	2	5	52	13	24	0	6	0	85											
22	18	5	48	0	4	54	0	0	0	37	2	6	1	7	49	18	31	0	6	0	28	78										
23	22	8	56	8	13	59	0	0	0	39	2	9	1	4	29	12	22	0	3	0	14	16	84									
24	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1								
25	43	20	171	11	13	124	0	0	0	97	5	10	2	5	88	30	38	0	10	0	37	33	45	0	217							
26	7	2	18	1	0	27	0	0	0	18	1	7	0	4	19	4	12	0	2	0	13	9	16	1	13	39						
27	50	23	189	10	15	162	0	1	0	128	9	16	3	7	112	35	59	0	12	0	60	45	68	1	156	25	260					
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
30	10	1	32	0	4	27	0	0	0	18	3	5	0	4	31	14	13	0	5	0	15	12	11	0	21	6	24	0	0	48		
31	33	15	109	3	17	90	0	0	0	53	3	0	0	6	53	23	26	0	21	0	16	23	22	1	56	10	64	0	0	17	127	
32	36	8	167	3	13	138	0	0	0	128	5	9	1	5	141	46	72	0	21	0	49	49	38	1	122	19	156	0	0	26	70	244

Site Number One - Yaquina Head　　　　Sampling Lines Number One and Two Combined

Observed value for the occurrence of each individual species and the expected values for the co-occurrence of any two species.*

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	21	22	23	24	25	26	27	28	29	30	31	32								
1	73.0																			
2	5.8	32.0																		
3	51.6	22.6	283.0																	
4	2.2	1.0	8.5	12.0																
5	5.5	2.4	21.2	.9	30.0															
6	44.9	19.7	174.0	7.4	18.4	246.0														
7	0	0	0	0	0	0	0													
8	.2	.1	.7	.0	.1	.6	0	1.0												
9	0	0	0	0	0	0	0	0	0											
10	32.5	14.2	125.9	5.3	13.3	109.5	0	.4	0	178.0										
11	2.4	1.0	9.2	.4	1.0	8.0	0	.0	0	5.8	13.0									
12	3.7	1.6	14.2	.6	1.5	12.3	0	.1	0	8.9	.6	20.0								
13	.7	.3	2.8	.1	.3	2.5	0	.0	0	1.8	.1	.2	4.0							
14	2.7	1.2	10.6	.4	1.1	9.2	0	.0	0	6.7	.5	.8	.1	15.0						
15	36.0	15.8	139.4	5.9	14.8	121.2	0	.5	0	87.7	6.4	9.9	2.0	7.4	197.0					
16	11.3	5.0	43.9	1.9	4.6	38.1	0	.2	0	27.6	2.0	3.1	.6	2.3	30.5	62.0				
17	18.1	7.9	70.0	3.0	7.4	60.9	0	.2	0	44.1	3.2	4.9	1.0	3.7	48.8	15.3	99.0			
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
19	5.7	2.5	21.9	.9	2.3	19.1	0	.1	0	13.8	1.0	1.5	.3	1.2	15.3	4.8	7.7	0	31.0	
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	15.5	6.8	60.1	2.6	6.4	52.3	0	.2	0	37.8	2.8	4.3	.9	3.2	41.9	13.2	21.0	0	6.6	0
	85.0																			
22	14.2	6.2	55.2	2.3	5.8	48.0	0	.2	0	34.7	2.5	3.9	.8	2.9	38.4	12.1	19.3	0	6.0	0
	16.6	78.0																		
23	15.3	6.7	59.4	2.5	6.3	51.7	0	.2	0	37.4	2.7	4.2	.8	3.1	41.4	13.0	20.8	0	6.5	0
	17.9	16.4	84.0																	
24	.2	.1	.7	.0	.1	.6	0	.0	0	.4	.0	.1	.0	.0	.5	.2	.2	0	.1	0
	.2	.2	.2	1.0																
25	39.6	17.4	153.5	6.5	16.3	133.5	0	.5	0	96.6	7.1	10.8	2.2	8.1	106.9	33.6	53.7	0	16.8	0
	46.1	42.3	45.6	.5	217.0															
26	7.1	3.1	27.6	1.2	2.9	24.0	0	.1	0	17.4	1.3	2.0	.4	1.5	19.2	6.0	9.7	0	3.0	0
	8.3	7.6	8.2	.1	21.2	39.0														
27	47.4	20.8	183.9	7.8	19.5	159.9	0	.6	0	115.7	8.4	13.0	2.6	9.7	128.1	40.3	64.3	0	20.1	0
	55.3	50.7	54.6	.6	141.1	25.3	260.0													
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0												
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0											
30	8.8	3.8	34.0	1.4	3.6	29.5	0	.1	0	21.4	1.6	2.4	.5	1.8	23.6	7.4	11.9	0	3.7	0
	10.2	9.4	10.1	.1	26.0	4.7	31.2	0	0	48.0										
31	23.2	10.2	89.9	3.8	9.5	78.1	0	.3	0	56.5	4.1	6.4	1.3	4.8	62.5	19.7	31.4	0	9.8	0
	27.0	24.8	26.7	.3	68.9	12.4	82.5	0	0	15.2	127.0									
32	44.5	19.5	172.6	7.3	18.3	150.1	0	.6	0	108.6	7.9	12.2	2.4	9.1	120.2	37.8	60.4	0	18.9	0
	51.9	47.6	51.2	.6	132.4	23.8	158.6	0	0	29.3	77.5	244.0								

CHI-SQUARE- 518.45

*Directions for reading values from this table: When comparing any two species, the larger species number is found on the vertical matrix index. The smaller species number is found on the horizontal matrix index. Note that the horizontal index is truncated for species numbers larger than 20. Values for species 21-32 are read in columns 1-12 in the second line following the vertical index species number. As an example, the value expected for the co-occurrence of species numbers 24 and 32 is 0.6.

Site Number Two - Boiler Bay Sampling Line Number One

Total number of segments in which each individual species occurs (diagonal) and total number of segments in which any two species are found to occur together (remainder of matrix).

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	0																															
2	0	0																														
3	0	0	1																													
4	0	0	0	44																												
5	0	0	0	0	0																											
6	0	0	1	33	0	149																										
7	0	0	0	0	0	0	0																									
8	0	0	0	0	0	0	0	0																								
9	0	0	0	5	0	38	0	0	53																							
10	0	0	1	6	0	34	0	0	11	49																						
11	0	0	1	43	0	135	0	0	43	44	181																					
12	0	0	0	0	0	0	0	0	0	0	0	0																				
13	0	0	0	18	0	82	0	0	26	23	102	0	109																			
14	0	0	1	39	0	135	0	0	48	42	164	0	102	181																		
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																	
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
17	0	0	0	0	0	2	0	0	2	0	1	0	1	3	0	0	3															
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0														
19	0	0	0	1	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1													
20	0	0	1	8	0	97	0	0	42	34	115	0	83	120	0	0	3	0	0	130												
21	0	0	0	0	0	1	0	0	0	1	3	0	1	3	0	0	0	0	0	3	3											
22	0	0	0	0	0	0	0	0	1	0	4	0	0	4	0	0	0	0	0	3	0	4										
23	0	0	0	18	0	17	0	0	0	1	22	0	10	21	0	0	0	0	0	1	0	0	22									
24	0	0	1	6	0	53	0	0	24	14	53	0	35	57	0	0	3	0	1	52	0	0	0	62								
25	0	0	1	42	0	127	0	0	40	38	138	0	83	139	0	0	3	0	1	101	2	0	22	53	154							
26	0	0	1	15	0	57	0	0	10	24	73	0	42	68	0	0	1	0	1	45	1	1	12	28	56	74						
27	0	0	1	29	0	45	0	0	0	15	59	0	25	53	0	0	1	0	1	23	1	1	20	16	55	33	59					
28	0	0	0	9	0	26	0	0	16	5	30	0	13	30	0	0	0	0	0	19	0	0	6	9	26	8	8	33				
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
30	0	0	0	1	0	2	0	0	1	2	2	0	1	3	0	0	1	0	0	1	0	0	0	1	3	1	1	0	0	3		
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Number Two - Boiler Bay Sampling Line Number One

Observed value for the occurrence of each individual species and the expected values for the co-occurrence of any two species.*

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	21	22	23	24	25	26	27	28	29	30	31	32								
1	0																			
2	0	0																		
3	0	0	1.0																	
4	0	0	.2	44.0																
5	0	0	0	0	0															
6	0	0	.7	32.8	0	149.0														
7	0	0	0	0	0	0	0													
8	0	0	0	0	0	0	0	0												
9	0	0	.3	11.7	0	39.5	0	0	53.0											
10	0	0	.2	10.8	0	36.5	0	0	13.0	49.0										
11	0	0	.9	39.8	0	134.8	0	0	48.0	44.3	181.0									
12	0	0	0	0	0	0	0	0	0	0	0	0								
13	0	0	.5	24.0	0	81.2	0	0	28.9	26.7	98.6	0	109.0							
14	0	0	.9	39.8	0	134.8	0	0	48.0	44.3	163.8	0	98.6	181.0						
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
17	0	0	.0	.7	0	2.2	0	0	.8	.7	2.7	0	1.6	2.7	0	0	3.0			
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
19	0	0	.0	.2	0	.7	0	0	.3	.2	.9	0	.5	.9	0	0	.0	0	1.0	
20	0	0	.6	28.6	0	96.8	0	0	34.4	31.8	117.6	0	70.8	117.6	0	0	2.0	0	.6	130.0
21	0	0	.0	.7	0	2.2	0	0	.8	.7	2.7	0	1.6	2.7	0	0	.0	0	.0	2.0
	3.0																			
22	0	0	.0	.9	0	3.0	0	0	1.1	1.0	3.6	0	2.2	3.6	0	0	.1	0	.0	2.6
	.1	4.0																		
23	0	0	.1	4.8	0	16.4	0	0	5.8	5.4	19.9	0	12.0	19.9	0	0	.3	0	.1	14.3
	.3	.4	22.0																	
24	0	0	.3	13.6	0	46.2	0	0	16.4	15.2	56.1	0	33.8	56.1	0	0	.9	0	.3	40.3
	.9	1.2	6.8	62.0																
25	0	0	.8	33.9	0	114.7	0	0	40.8	37.7	139.4	0	83.9	139.4	0	0	2.3	0	.8	100.1
	2.3	3.1	16.9	47.7	154.0															
26	0	0	.4	16.3	0	55.1	0	0	19.6	18.1	67.0	0	40.3	67.0	0	0	1.1	0	.4	48.1
	1.1	1.5	8.1	22.9	57.0	74.0														
27	0	0	.3	13.0	0	44.0	0	0	15.6	14.5	53.4	0	32.2	53.4	0	0	.9	0	.3	38.3
	.9	1.2	6.5	18.3	45.4	21.8	59.0													
28	0	0	.2	7.3	0	24.6	0	0	8.7	8.1	29.9	0	18.0	29.9	0	0	.5	0	.2	21.5
	.5	.7	3.6	10.2	25.4	12.2	9.7	33.0												
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0											
30	0	0	.0	.7	0	2.2	0	0	.8	.7	2.7	0	1.6	2.7	0	0	.0	0	.0	2.0
	.0	.1	.3	.9	2.3	1.1	.9	.5	0	3.0										
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0									
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0								

CHI-SQUARE- 286.56

*Directions for reading values from this table: When comparing any two species, the larger species number is found on the vertical matrix index. The smaller species number is found on the horizontal matrix index. Note that the horizontal index is truncated for species numbers larger than 20. Values for species 21-32 are read in columns 1-12 in the second line following the vertical index species number. As an example, the value expected for the co-occurrence of species numbers 21 and 22 is 0.1.

Site Number Two - Boiler Bay Sampling Line Number Two

Total number of segments in which each individual species occurs (diagonal) and total number of segments in which any two species are found to occur together (remainder of matrix).

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	3																															
2	0	8																														
3	0	2	35																													
4	0	4	8	73																												
5	0	1	8	46	67																											
6	2	6	25	33	32	142																										
7	0	0	0	0	0	0	0																									
8	0	0	0	0	0	0	0	0																								
9	0	0	0	0	0	0	0	0	0																							
10	0	1	23	27	33	64	0	0	0	84																						
11	3	8	21	56	46	87	0	0	0	55	124																					
12	0	1	3	0	0	12	0	0	0	7	7	12																				
13	0	1	6	2	2	42	0	0	0	25	24	8	43																			
14	2	6	18	25	18	76	0	0	0	36	56	9	31	90																		
15	0	0	0	0	0	1	0	0	0	0	1	0	0	1	1																	
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
17	1	1	11	13	15	23	0	0	0	14	26	2	4	14	1	0	37															
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0														
19	0	1	0	1	1	3	0	0	0	2	2	0	2	2	0	0	0	0	3													
20	2	2	8	1	0	37	0	0	0	15	23	4	16	23	0	0	6	0	0	45												
21	0	2	1	0	1	4	0	0	0	2	3	3	2	4	0	0	1	0	0	3	5											
22	1	1	3	6	8	9	0	0	0	7	11	0	1	3	0	0	5	0	0	3	0	15										
23	1	6	22	69	62	68	0	0	0	46	83	2	9	42	0	0	28	0	2	9	2	10	116									
24	0	1	1	0	0	7	0	0	0	3	3	0	4	4	0	0	1	0	0	6	0	0	2	8								
25	1	7	18	39	37	78	0	0	0	47	75	6	30	60	1	0	17	0	3	29	4	7	60	7	110							
26	0	3	7	8	7	25	0	0	0	16	26	3	12	20	0	0	8	0	0	8	3	5	11	2	20	31						
27	3	7	23	53	49	95	0	0	0	54	95	5	26	63	0	0	24	0	2	37	4	14	86	6	84	21	141					
28	2	0	1	0	0	3	0	0	0	1	2	0	1	2	0	0	1	0	0	2	0	1	2	2	3	0	4	5				
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
30	2	1	10	1	1	38	0	0	0	21	21	7	21	28	1	0	6	0	1	15	2	2	8	4	27	9	20	3	0	40		
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
32	0	1	13	52	48	44	0	0	0	38	54	0	3	22	0	0	23	0	1	0	1	9	75	0	40	8	57	1	0	2	0	81

Site Number Two - Boiler Bay Sampling Line Number Two

Observed value for the occurrence of each individual species and the expected values for the co-occurrence of any two species.*

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1 / 21	2 / 22	3 / 23	4 / 24	5 / 25	6 / 26	7 / 27	8 / 28	9 / 29	10 / 30	11 / 31	12 / 32	13	14	15	16	17	18	19	20
1	3.0																			
2	.1	8.0																		
3	.5	1.4	35.0																	
4	1.1	2.9	12.8	73.0																
5	1.0	2.7	11.7	24.5	67.0															
6	2.1	5.7	24.9	51.8	47.6	142.0														
7	0	0	0	0	0	0	0													
8	0	0	0	0	0	0	0	0												
9	0	0	0	0	0	0	0	0	0											
10	1.3	3.4	14.7	30.7	28.1	59.6	0	0	0	84.0										
11	1.9	5.0	21.7	45.3	41.5	88.0	0	0	0	52.1	124.0									
12	.2	.5	2.1	4.4	4.0	8.5	0	0	0	5.0	7.4	12.0								
13	.6	1.7	7.5	15.7	14.4	30.5	0	0	0	18.1	26.7	2.6	43.0							
14	1.4	3.6	15.7	32.8	30.1	63.9	0	0	0	37.8	55.8	5.4	19.3	90.0						
15	.0	.0	.2	.4	.3	.7	0	0	0	.4	.6	.1	.2	.4	1.0					
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
17	.6	1.5	6.5	13.5	12.4	26.3	0	0	0	15.5	22.9	2.2	8.0	16.6	.2	0	37.0			
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
19	.0	.1	.5	1.1	1.0	2.1	0	0	0	1.3	1.9	.2	.6	1.4	.0	0	.6	0	3.0	
20	.7	1.8	7.9	16.4	15.1	32.0	0	0	0	18.9	27.9	2.7	9.7	20.2	.2	0	8.3	0	.7	45.8
21	.1	.2	.9	1.8	1.7	3.6	0	0	0	2.1	3.1	.3	1.1	2.3	.0	0	.9	0	.1	1.1
	5.0																			
22	.2	.6	2.6	5.5	5.0	10.6	0	0	0	6.3	9.3	.9	3.2	6.8	.1	0	2.8	0	.2	3.4
	.4	15.0																		
23	1.7	4.6	20.3	42.3	38.9	82.4	0	0	0	48.7	71.9	7.0	24.9	52.2	.6	0	21.5	0	1.7	26.1
	2.9	8.7	116.0																	
24	.1	.3	1.4	2.9	2.7	5.7	0	0	0	3.4	5.0	.5	1.7	3.6	.0	0	1.5	0	.1	1.8
	.2	.6	4.6	8.0																
25	1.7	4.4	19.2	40.1	36.8	78.1	0	0	0	46.2	68.2	6.6	23.6	49.5	.6	0	20.4	0	1.7	24.8
	2.8	8.3	63.8	4.4	110.0															
26	.5	1.2	5.4	11.3	10.4	22.0	0	0	0	13.0	19.2	1.9	6.7	13.9	.2	0	5.7	0	.5	7.0
	.8	2.3	18.0	1.2	17.0	31.0														
27	2.1	5.6	24.7	51.5	47.2	100.1	0	0	0	59.2	87.4	8.5	30.3	63.4	.7	0	26.1	0	2.1	31.7
	3.5	10.6	81.8	5.6	77.6	21.9	141.0													
28	.1	.2	.9	1.8	1.7	3.6	0	0	0	2.1	3.1	.3	1.1	2.3	.0	0	.9	0	.1	1.1
	.1	.4	2.9	.2	2.8	.8	3.5	5.0												
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0											
30	.6	1.6	7.0	14.6	13.4	28.4	0	0	0	16.8	24.8	2.4	8.6	18.0	.2	0	7.4	0	.6	9.0
	1.0	3.0	23.2	1.6	22.0	6.2	28.2	1.0	0	40.0										
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0									
32	1.2	3.2	14.2	29.6	27.1	57.5	0	0	0	34.0	50.2	4.9	17.4	36.4	.4	0	15.0	0	1.2	18.2
	2.0	6.1	47.0	3.2	44.5	12.6	57.1	2.0	0	16.2	0	81.0								

CHI-SQUARE- 690.97

*Directions for reading values from this table: When comparing any two species, the larger species number is found on the vertical matrix index. The smaller species number is found on the horizontal matrix index. Note that the horizontal index is truncated for species numbers larger than 20. Values for species 21-32 are read in columns 1-12 in the second line following the vertical index species number. As an example, the value expected for the co-occurrence of species numbers 26 and 29 is 0.0.

Site Number Two - Boiler Bay Sampling Lines Number One and Two Combined

Total number of segments in which each individual species occurs (diagonal) and total number of segments in which any two species are found to occur together (remainder of matrix).

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	3																															
2	0	8																														
3	0	2	36																													
4	0	4	8	117																												
5	0	1	8	46	67																											
6	2	6	26	66	32	291																										
7	0	0	0	0	0	0	0																									
8	0	0	0	0	0	0	0	0																								
9	0	0	0	5	0	38	0	0	53																							
10	0	1	24	33	33	98	0	0	11	133																						
11	3	8	22	99	46	222	0	0	43	99	305																					
12	0	1	3	0	0	12	0	0	0	7	7	12																				
13	0	1	6	20	2	124	0	0	26	48	126	8	152																			
14	2	6	19	64	18	211	0	0	48	78	220	9	133	271																		
15	0	0	0	0	0	1	0	0	0	0	1	0	0	1	1																	
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
17	1	1	11	13	15	25	0	0	2	14	27	2	5	17	1	0	40															
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0														
19	0	1	0	2	1	3	0	0	0	2	3	0	3	3	0	0	0	0	4													
20	2	2	9	9	0	134	0	0	42	49	138	4	99	143	0	0	9	0	0	175												
21	0	2	1	0	1	5	0	0	0	3	6	3	3	7	0	0	1	0	0	6	8											
22	1	1	3	6	8	9	0	0	1	7	15	0	1	7	0	0	5	0	0	6	0	19										
23	1	6	22	87	62	85	0	0	0	47	105	2	19	63	0	0	28	0	2	10	2	10	138									
24	0	1	2	6	0	60	0	0	24	17	56	0	39	61	0	0	4	0	1	58	0	0	2	70								
25	1	7	19	81	37	205	0	0	40	85	213	6	113	199	1	0	20	0	4	130	6	7	82	60	264							
26	0	3	8	23	7	82	0	0	10	40	99	3	54	88	0	0	9	0	1	53	4	6	23	30	76	105						
27	3	7	24	82	49	140	0	0	0	69	154	5	51	116	0	0	25	0	3	60	5	15	106	22	139	54	200					
28	2	0	1	9	0	29	0	0	16	6	32	0	14	32	0	0	1	0	0	21	0	1	8	11	29	8	12	38				
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
30	2	1	10	2	1	40	0	0	1	23	23	7	22	31	1	0	7	0	1	16	2	2	8	5	30	10	21	3	0	43		
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
32	0	1	13	52	48	44	0	0	0	38	54	0	3	22	0	0	23	0	1	0	1	9	75	0	40	8	57	1	0	2	0	81

Site Number Two - Boiler Bay Sampling Lines Number One and Two Combined

Observed value for the occurrence of each individual species and the expected values for the co-occurrence of any two species.*

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1 21	2 22	3 23	4 24	5 25	6 26	7 27	8 28	9 29	10 30	11 31	12 32	13	14	15	16	17	18	19	20
1	3.0																			
2	.1	8.0																		
3	.3	.7	36.0																	
4	.9	2.3	10.5	117.0																
5	.5	1.3	6.0	19.6	67.0															
6	2.2	5.8	26.2	85.1	48.7	291.0														
7	0	0	0	0	0	0	0													
8	0	0	0	0	0	0	0	0												
9	.4	1.1	4.8	15.5	8.9	38.6	0	0	53.0											
10	1.0	2.7	12.0	38.9	22.3	96.8	0	0	17.6	133.0										
11	2.3	6.1	27.5	89.2	51.1	221.9	0	0	40.4	101.4	305.0									
12	.1	.2	1.1	3.5	2.0	8.7	0	0	1.6	4.0	9.2	12.0								
13	1.1	3.0	13.7	44.5	25.5	110.6	0	0	20.1	50.5	115.9	4.6	152.0							
14	2.0	5.4	24.4	79.3	45.4	197.2	0	0	35.9	90.1	206.6	8.1	103.0	271.0						
15	.0	.0	.1	.3	.2	.7	0	0	.1	.3	.8	.0	.4	.7	1.0					
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
17	.3	.8	3.6	11.7	6.7	29.1	0	0	5.3	13.3	30.5	1.2	15.2	27.1	.1	0	40.0			
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
19	.0	.1	.4	1.2	.7	2.9	0	0	.5	1.3	3.0	.1	1.5	2.7	.0	0	.4	0	4.0	
20	1.3	3.5	15.8	51.2	29.3	127.3	0	0	23.2	58.2	133.4	5.3	66.5	118.6	.4	0	17.5	0	1.8	175.0
21	.1	.2	.7	2.3	1.3	5.8	0	0	1.1	2.7	6.1	.2	3.0	5.4	.0	0	.8	0	.1	3.5
	8.0																			
22	.1	.4	1.7	5.6	3.2	13.8	0	0	2.5	6.3	14.5	.6	7.2	12.9	.0	0	1.9	0	.2	8.3
	.4	19.0																		
23	1.0	2.8	12.4	40.4	23.1	100.4	0	0	18.3	45.9	105.2	4.1	52.4	93.5	.3	0	13.8	0	1.4	60.4
	2.8	6.6	138.0																	
24	.5	1.4	6.3	20.5	11.7	50.9	0	0	9.3	23.3	53.4	2.1	26.6	47.4	.2	0	7.0	0	.7	30.6
	1.4	3.3	24.1	70.0																
25	2.0	5.3	23.8	77.2	44.2	192.1	0	0	35.0	87.8	201.3	7.9	100.3	178.9	.7	0	26.4	0	2.6	115.5
	5.3	12.5	91.1	46.2	264.0															
26	.8	2.1	9.4	30.7	17.6	76.4	0	0	13.9	34.9	80.1	3.2	39.9	71.1	.3	0	10.5	0	1.0	45.9
	2.1	5.0	36.2	18.4	69.3	105.0														
27	1.5	4.0	18.0	58.5	33.5	145.5	0	0	26.5	66.5	152.5	6.0	76.0	135.5	.5	0	20.0	0	2.0	87.5
	4.0	9.5	69.0	35.0	132.0	52.5	200.0													
28	.3	.8	3.4	11.1	6.4	27.6	0	0	5.0	12.6	29.0	1.1	14.4	25.7	.1	0	3.8	0	.4	16.6
	.8	1.8	13.1	6.6	25.1	10.0	19.0	38.0												
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0											
30	.3	.9	3.9	12.6	7.2	31.3	0	0	5.7	14.3	32.8	1.3	16.3	29.1	.1	0	4.3	0	.4	18.8
	.9	2.0	14.8	7.5	28.4	11.3	21.5	4.1	0	43.0										
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0									
32	.6	1.6	7.3	23.7	13.6	58.9	0	0	10.7	26.9	61.8	2.4	30.8	54.9	.2	0	8.1	0	.8	35.4
	1.6	3.8	27.9	14.2	53.5	21.3	40.5	7.7	0	8.7	0	81.0								

CHI-SQUARE- 1535.98

*Directions for reading values from this table: When comparing any two species, the larger species number is found on the vertical matrix index. The smaller species number is found on the horizontal matrix index. Note that the horizontal index is truncated for species numbers larger than 20. Values for species 21-32 are read in columns 1-12 in the second line following the vertical index species number. As an example, the value expected for the co-occurrence of species numbers 22 and 30 is 2.0.

Site Number Three - Strawberry Hill Sampling Line Number One

Total number of segments in which each individual species occurs (diagonal) and total number of segments in which any two species are found to occur together (remainder of matrix).

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	16																															
2	0	2																														
3	0	0	70																													
4	0	0	4	30																												
5	0	1	33	16	84																											
6	0	1	36	13	45	89																										
7	0	0	4	5	10	10	22																									
8	0	0	0	0	0	0	0	0																								
9	0	0	0	0	0	0	0	0	0																							
10	0	0	8	3	8	17	0	0	0	18																						
11	0	0	16	13	31	44	6	0	0	12	71																					
12	0	0	0	0	0	1	0	0	0	1	1	1																				
13	0	0	9	2	7	15	0	0	0	9	10	1	16																			
14	0	2	14	5	20	23	4	0	0	5	15	1	6	38																		
15	0	0	3	2	4	14	0	0	0	10	13	1	4	8	15																	
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
17	0	0	26	6	28	34	4	0	0	8	29	0	5	14	7	0	61															
18	0	0	4	2	5	0	4	0	0	0	3	0	0	3	0	0	3	16														
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0													
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0												
21	0	0	8	2	5	5	0	0	0	2	2	0	2	2	2	0	5	0	0	0	13											
22	0	0	0	0	0	1	0	0	0	0	2	0	0	1	0	0	1	1	0	0	0	2										
23	4	2	51	22	58	64	12	0	0	9	57	0	9	23	7	0	53	13	0	0	4	2	142									
24	0	0	2	0	1	0	2	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	1	2								
25	4	1	12	7	19	20	10	0	0	2	9	0	3	8	1	0	14	2	0	0	1	0	30	0	41							
26	0	0	2	0	1	2	0	0	0	2	1	0	2	0	1	0	2	0	0	0	1	0	1	0	2	2						
27	0	0	8	6	15	19	0	0	0	5	17	0	8	4	2	0	7	1	0	0	3	1	20	0	4	1	27					
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
29	0	0	0	0	0	2	0	0	0	1	2	0	1	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	2			
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
31	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	
32	0	2	51	15	50	37	6	0	0	10	32	0	6	23	11	0	33	13	0	0	12	1	82	2	18	2	11	0	1	0	0	117

Site Number Three - Strawberry Hill Sampling Line Number One

Observed value for the occurrence of each individual species and the expected values for the co-occurrence of any two species*

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1 21	2 22	3 23	4 24	5 25	6 26	7 27	8 28	9 29	10 30	11 31	12 32	13	14	15	16	17	18	19	20
1	16.0																			
2	.2	2.0																		
3	5.6	.7	70.0																	
4	2.4	.3	10.5	30.0																
5	6.7	.8	29.4	12.6	84.0															
6	7.1	.9	31.1	13.3	37.4	89.0														
7	1.8	.2	7.7	3.3	9.2	9.8	22.0													
8	0	0	0	0	0	0	0	0												
9	0	0	0	0	0	0	0	0	0											
10	1.4	.2	6.3	2.7	7.6	8.0	2.0	0	0	18.0										
11	5.7	.7	24.9	10.6	29.8	31.6	7.8	0	0	6.4	71.0									
12	.1	.0	.4	.1	.4	.4	.1	0	0	.1	.4	1.0								
13	1.3	.2	5.6	2.4	6.7	7.1	1.8	0	0	1.4	5.7	.1	16.0							
14	3.0	.4	13.3	5.7	16.0	16.9	4.2	0	0	3.4	13.5	.2	3.0	38.0						
15	1.2	.1	5.3	2.2	6.3	6.7	1.6	0	0	1.4	5.3	.1	1.2	2.8	15.0					
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
17	4.9	.6	21.3	9.1	25.6	27.1	6.7	0	0	5.5	21.7	.3	4.9	11.6	4.6	0	61.0			
18	1.3	.2	5.6	2.4	6.7	7.1	1.8	0	0	1.4	5.7	.1	1.3	3.0	1.2	0	4.9	16.0		
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	1.0	.1	4.5	1.9	5.5	5.8	1.4	0	0	1.2	4.6	.1	1.0	2.5	1.0	0	4.0	1.0	0	0
	13.0																			
22	.2	.0	.7	.3	.8	.9	.2	0	0	.2	.7	.0	.2	.4	.1	0	.6	.2	0	0
	.1	2.0																		
23	11.4	1.4	49.7	21.3	59.6	63.2	15.6	0	0	12.8	50.4	.7	11.4	27.0	10.6	0	43.3	11.4	0	0
	9.2	1.4	142.0																	
24	.2	.0	.7	.3	.8	.9	.2	0	0	.2	.7	.0	.2	.4	.1	0	.6	.2	0	0
	.1	.0	1.4	2.0																
25	3.3	.4	14.4	6.2	17.2	18.2	4.5	0	0	3.7	14.6	.2	3.3	7.8	3.1	0	12.5	3.3	0	0
	2.7	.4	29.1	.4	41.0															
26	.2	.0	.7	.3	.8	.9	.2	0	0	.2	.7	.0	.2	.4	.1	0	.6	.2	0	0
	.1	.0	1.4	.0	.4	2.0														
27	2.2	.3	9.4	4.0	11.3	12.0	3.0	0	0	2.4	9.6	.1	2.2	5.1	2.0	0	8.2	2.2	0	0
	1.8	.3	19.2	.3	5.5	.3	27.0													
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0												
29	.2	.0	.7	.3	.8	.9	.2	0	0	.2	.7	.0	.2	.4	.1	0	.6	.2	0	0
	.1	.0	1.4	.0	.4	.0	.3	0	2.0											
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0										
31	.1	.0	.4	.1	.4	.4	.1	0	0	.1	.4	.0	.1	.2	.1	0	.3	.1	0	0
	.1	.0	.7	.0	.2	.0	.1	0	.0	0	1.0									
32	9.4	1.2	40.9	17.5	49.1	52.1	12.9	0	0	10.5	41.5	.6	9.4	22.2	8.8	0	35.7	9.4	0	0
	7.6	1.2	83.1	1.2	24.0	1.2	15.8	0	1.2	0	.6	117.0								

CHI-SQUARE- 566.02

*Directions for reading values from this table: When comparing any two species, the larger species number is found on the vertical matrix index. The smaller species number is found on the horizontal matrix index. Note that the horizontal index is truncated for species numbers larger than 20. Values for species 21-32 are read in columns 1-12 in the second line following the vertical index species number. As an example, the value expected for the co-occurrence of species numbers 31 and 32 is 0.6.

Site Number Three - Strawberry Hill — Sampling Line Number Two

Total number of segments in which each individual species occurs (diagonal) and total number of segments in which any two species are found to occur together (remainder of matrix).

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	0																															
2	0	0																														
3	0	0	141																													
4	0	0	11	16																												
5	0	0	52	8	63																											
6	0	0	62	4	30	75																										
7	0	0	1	4	3	1	9																									
8	0	0	14	0	4	14	0	15																								
9	0	0	0	0	0	0	0	0	0																							
10	0	0	11	0	6	4	0	3	0	13																						
11	0	0	28	2	17	26	3	7	0	2	35																					
12	0	0	3	0	1	4	0	4	0	2	3	4																				
13	0	0	6	0	3	7	0	5	0	2	3	1	8																			
14	0	0	49	4	22	24	2	12	0	7	16	4	8	62																		
15	0	0	11	1	4	4	0	0	0	3	3	0	0	2	12																	
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
17	0	0	68	4	25	32	0	5	0	8	14	0	2	19	9	0	72															
18	0	0	9	4	3	3	3	0	0	1	2	0	0	3	1	0	4	15														
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0													
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0												
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
22	0	0	7	0	1	5	0	2	0	2	2	0	0	1	0	0	6	0	0	0	0	8										
23	0	0	91	7	34	41	0	4	0	6	17	0	2	30	8	0	60	7	0	0	0	5	103									
24	0	0	2	0	2	2	3	0	0	0	3	0	0	2	0	0	0	1	0	0	0	0	0	5								
25	0	0	14	2	7	12	2	6	0	3	8	3	3	11	0	0	10	1	0	0	0	0	12	0	21							
26	0	0	3	0	2	3	0	2	0	2	2	1	2	3	0	0	1	0	0	0	0	0	0	0	2	3						
27	0	0	9	1	2	7	0	3	0	1	4	3	0	4	2	0	5	0	0	0	0	1	5	0	3	1	9					
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
29	0	0	4	0	1	5	1	3	0	0	4	0	0	4	0	0	1	0	0	0	0	0	2	1	2	0	1	0	5			
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
32	0	0	132	13	61	65	7	13	0	12	30	2	8	58	9	0	67	15	0	0	0	8	98	5	18	2	4	0	5	0	0	178

Site Number Three - Strawberry Hill　　　　Sampling Line Number Two

Observed value for the occurrence of each individual species and the expected values for the co-occurrence of any two species.*

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1 21	2 22	3 23	4 24	5 25	6 26	7 27	8 28	9 29	10 30	11 31	12 32	13	14	15	16	17	18	19	20
1	0																			
2	0	0																		
3	0	0	141.0																	
4	0	0	11.3	16.0																
5	0	0	44.4	5.0	63.0															
6	0	0	52.9	6.0	23.6	75.0														
7	0	0	6.3	.7	2.8	3.4	9.0													
8	0	0	10.6	1.2	4.7	5.6	.7	15.0												
9	0	0	0	0	0	0	0	0	0											
10	0	0	9.2	1.0	4.1	4.9	.6	1.0	0	13.0										
11	0	0	24.7	2.8	11.0	13.1	1.6	2.6	0	2.3	35.0									
12	0	0	2.8	.3	1.3	1.5	.2	.3	0	.3	.7	4.0								
13	0	0	5.6	.6	2.5	3.0	.4	.6	0	.5	1.4	.2	8.0							
14	0	0	43.7	5.0	19.5	23.3	2.8	4.6	0	4.0	10.8	1.2	2.5	62.0						
15	0	0	8.5	1.0	3.8	4.5	.5	.9	0	.8	2.1	.2	.5	3.7	12.0					
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
17	0	0	50.8	5.8	22.7	27.0	3.2	5.4	0	4.7	12.6	1.4	2.9	22.3	4.3	0	72.0			
18	0	0	10.6	1.2	4.7	5.6	.7	1.1	0	1.0	2.6	.3	.6	4.6	.9	0	5.4	15.0		
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0																			
22	0	0	5.6	.6	2.5	3.0	.4	.6	0	.5	1.4	.2	.3	2.5	.5	0	2.9	.6	0	0
	0	8.0																		
23	0	0	72.6	8.2	32.4	38.6	4.6	7.7	0	6.7	18.0	2.1	4.1	31.9	6.2	0	37.1	7.7	0	0
	0	4.1	103.0																	
24	0	0	3.5	.4	1.6	1.9	.2	.4	0	.3	.9	.1	.2	1.5	.3	0	1.8	.4	0	0
	0	.2	2.6	5.0																
25	0	0	14.8	1.7	6.6	7.9	.9	1.6	0	1.4	3.7	.4	.8	6.5	1.3	0	7.6	1.6	0	0
	0	.8	10.8	.5	21.0															
26	0	0	2.1	.2	.9	1.1	.1	.2	0	.2	.5	.1	.1	.9	.2	0	1.1	.2	0	0
	0	.1	1.5	.1	.3	3.0														
27	0	0	6.3	.7	2.8	3.4	.4	.7	0	.6	1.6	.2	.4	2.8	.5	0	3.2	.7	0	0
	0	.4	4.6	.2	.9	.1	9.0													
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0												
29	0	0	3.5	.4	1.6	1.9	.2	.4	0	.3	.9	.1	.2	1.5	.3	0	1.8	.4	0	0
	0	.2	2.6	.1	.5	.1	.2	0	5.0											
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0										
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0									
32	0	0	125.5	14.2	56.1	66.8	8.0	13.3	0	11.6	31.1	3.6	7.1	55.2	10.7	0	64.1	13.3	0	0
	0	7.1	91.7	4.4	18.7	2.7	8.0	0	4.4	0	0	178.0								

CHI-SQUARE- 669.76

*Directions for reading values from this table: When comparing any two species, the larger species number is found on the vertical matrix index. The smaller species number is found on the horizontal matrix index. Note that the horizontal index is truncated for species numbers larger than 20. Values for species 21-32 are read in columns 1-12 in the second line following the vertical index species number. As an example, the value expected for the co-occurrence of species numbers 23 and 29 is 2.6.

Site Number Three - Strawberry Hill Sampling Lines Number One and Two Combined

Total number of segments in which each individual species occurs (diagonal) and total number of segments in which any two species are found to occur together (remainder of matrix).

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	16															
2	0	2														
3	0	0	211													
4	0	0	15	46												
5	0	1	85	24	147											
6	0	1	98	17	75	164										
7	0	0	5	9	13	11	31									
8	0	0	14	0	4	14	0	15								
9	0	0	0	0	0	0	0	0	0							
10	0	0	19	3	14	21	0	3	0	31						
11	0	0	44	15	48	70	9	7	0	14	106					
12	0	0	3	0	1.	5	0	4	0	3	4	5				
13	0	0	15	2	10	22	0	5	0	11	13	2	24			
14	0	2	63	9	42	47	6	12	0	12	31	5	14	100		
15	0	0	14	3	8	18	0	0	0	13	16	1	4	10	27	
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	94	10	53	66	4	5	0	16	43	0	7	33	16	0
18	0	0	13	6	8	3	7	0	0	1	5	0	0	6	1	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	8	2	5	5	0	0	0	2	2	0	2	2	2	0
22	0	0	7	0	1	6	0	2	0	2	4	0	0	2	0	0
23	4	2	142	29	92	105	12	4	0	15	74	0	11	53	15	0
24	0	0	4	0	3	2	5	0	0	0	5	0	0	3	0	0
25	4	1	26	9	26	32	12	6	0	5	17	3	6	19	1	0
26	0	0	5	0	3	5	0	2	0	4	3	1	4	3	1	0
27	0	0	17	7	17	26	0	3	0	6	21	3	8	8	4	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	4	0	1	7	1	3	0	1	6	0	1	5	1	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
32	0	2	183	28	111	102	13	13	0	22	62	2	14	81	20	0

	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
17	133															
18	7	31														
19	0	0	0													
20	0	0	0	0												
21	5	0	0	0	13											
22	7	1	0	0	0	10										
23	113	20	0	0	4	7	245									
24	0	1	0	0	0	0	1	7								
25	24	3	0	0	1	0	42	0	62							
26	3	0	0	0	1	0	1	0	4	5						
27	12	1	0	0	3	2	25	0	7	2	36					
28	0	0	0	0	0	0	0	0	0	0	0	0				
29	2	0	0	0	0	0	3	1	2	0	1	0	7			
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
31	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	
32	100	28	0	0	12	9	180	7	36	4	15	0	6	0	0	295

Site Number Three - Strawberry Hill — Sampling Lines Number One and Two Combined

Observed value for the occurrence of each individual species and the expected values for the co-occurrence of any two species.*

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1 21	2 22	3 23	4 24	5 25	6 26	7 27	8 28	9 29	10 30	11 31	12 32	13	14	15	16	17	18	19	20
1	16.0																			
2	.1	2.0																		
3	8.4	1.1	211.0																	
4	1.9	.2	24.3	46.0																
5	5.9	.7	77.5	16.9	147.0															
6	6.6	.8	35.5	18.9	60.3	164.0														
7	1.2	.2	16.4	3.6	11.4	12.7	31.0													
8	.6	.1	7.9	1.7	5.5	6.2	1.2	15.0												
9	0	0	0	0	0	0	0	0	0											
10	1.2	.2	16.4	3.6	11.4	12.7	2.4	1.2	0	31.0										
11	4.7	.5	55.9	12.2	39.0	43.5	8.2	4.0	0	8.2	106.0									
12	.2	.0	2.6	.6	1.8	2.0	.4	.2	0	.4	1.3	5.0								
13	1.0	.1	12.7	2.8	8.8	9.8	1.9	.9	0	1.9	6.4	.3	24.0							
14	4.0	.5	52.8	11.5	36.8	41.0	7.8	3.8	0	7.8	26.5	1.3	6.0	100.0						
15	1.1	.1	14.2	3.1	9.9	11.1	2.1	1.0	0	2.1	7.2	.3	1.6	6.8	27.0					
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
17	5.3	.7	70.2	15.3	48.9	54.5	10.3	5.0	0	10.3	35.2	1.7	8.0	33.3	9.0	0	133.0			
18	1.2	.2	16.4	3.6	11.4	12.7	2.4	1.2	0	2.4	8.2	.4	1.9	7.8	2.1	0	10.3	31.0		
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	.5	.1	5.9	1.5	4.8	5.3	1.0	.5	0	1.0	3.4	.2	.8	3.2	.9	0	4.3	1.0	0	0
	13.0																			
22	.4	.1	5.3	1.1	3.7	4.1	.8	.4	0	.8	2.7	.1	.6	2.5	.7	0	3.3	.8	0	0
	.3	10.0																		
23	9.8	1.2	129.2	28.2	90.0	100.4	19.0	9.2	0	19.0	64.9	3.1	14.7	61.3	16.5	0	81.5	19.0	0	0
	8.0	6.1	245.0																	
24	.3	.0	3.7	.8	2.6	2.9	.5	.3	0	.5	1.9	.1	.4	1.8	.5	0	2.3	.5	0	0
	.2	.2	4.3	7.0																
25	2.5	.3	32.7	7.1	22.8	25.4	4.8	2.3	0	4.8	16.4	.8	3.7	15.5	4.2	0	20.6	4.8	0	0
	2.0	1.5	39.0	1.1	62.0															
26	.2	.0	2.6	.6	1.8	2.0	.4	.2	0	.4	1.3	.1	.3	1.3	.3	0	1.7	.4	0	0
	.2	.1	3.1	.1	.8	5.0														
27	1.4	.2	19.0	4.1	13.2	14.8	2.8	1.4	0	2.8	9.5	.4	2.2	9.0	2.4	0	12.0	2.8	0	0
	1.2	.9	22.1	.6	5.6	.4	36.0													
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0												
29	.3	.0	3.7	.8	2.6	2.9	.5	.3	0	.5	1.9	.1	.4	1.8	.5	0	2.3	.5	0	0
	.2	.2	4.3	.1	1.1	.1	.6	0	7.0											
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0										
31	.0	.0	.5	.1	.4	.4	.1	.0	0	.1	.3	.0	.1	.3	.1	0	.3	.1	0	0
	.0	.0	.6	.0	.2	.3	.1	0	.0	0	1.0									
32	11.8	1.5	155.6	33.9	108.4	121.0	22.9	11.1	0	22.9	78.2	3.7	17.7	73.8	19.9	0	98.1	22.9	0	0
	9.6	7.4	180.7	5.2	45.7	3.7	26.5	0	5.2	0	.7	295.0								

CHI-SQUARE- 1029.99

*Directions for reading values from this table: When comparing any two species, the larger species number is found on the vertical matrix index. The smaller species number is found on the horizontal matrix index. Note that the horizontal index is truncated for species numbers larger than 20. Values for species 21-32 are read in columns 1-12 in the second line following the vertical index species number. As an example, the value expected for the co-occurrence of species numbers 23 and 29 is 4.3.

Sites Number One, Two, and Three Combined

Total number of segments in which each individual species occurs (diagonal) and total number of segments in which any two species are found to occur together (remainder of matrix).

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	92																															
2	9	42																														
3	63	27	530																													
4	7	5	33	175																												
5	9	6	117	73	244																											
6	63	32	294	91	132	701																										
7	0	0	5	9	13	11	31																									
8	0	0	14	0	4	14	0	16																								
9	0	0	0	5	0	38	0	0	53																							
10	31	10	167	37	59	233	0	3	11	342																						
11	6	9	72	115	96	305	9	7	43	117	424																					
12	2	1	14	0	1	32	0	4	0	13	13	37																				
13	1	2	23	22	12	149	0	5	26	59	139	12	180																			
14	6	11	93	73	63	272	6	12	48	101	251	14	147	386																		
15	26	6	143	3	14	136	0	1	0	98	23	13	5	20	225																	
16	17	3	44	0	2	32	0	0	0	29	1	3	0	2	46	62																
17	19	5	170	25	76	150	4	6	2	81	70	9	12	57	90	19	272															
18	0	0	13	6	8	3	7	0	0	1	5	0	0	6	1	0	7	31														
19	9	3	27	2	3	19	0	1	0	14	4	0	3	6	21	8	7	0	35													
20	2	2	9	9	0	134	0	0	42	49	138	4	99	143	0	0	9	0	0	175												
21	16	6	59	2	10	71	0	0	0	45	15	14	7	14	54	13	30	0	6	6	106											
22	19	5	58	6	13	69	0	2	1	46	21	6	2	16	49	18	43	1	6	6	28	107										
23	27	16	220	124	167	249	12	4	0	101	181	11	31	120	44	12	163	20	5	10	20	33	467									
24	0	2	6	6	3	63	5	0	24	17	61	0	39	64	0	0	5	1	1	58	0	0	3	78								
25	48	28	216	101	76	361	12	6	40	187	235	19	121	223	90	30	82	3	14	130	44	40	169	60	543							
26	7	5	31	24	10	114	0	2	10	62	103	11	58	95	20	4	24	0	3	53	18	15	40	31	93	149						
27	53	30	230	99	81	328	0	4	0	203	184	24	62	131	116	35	96	1	15	60	68	62	199	23	302	81	496					
28	2	0	1	9	0	29	0	0	16	6	32	0	14	32	0	0	1	0	0	21	0	1	8	11	29	8	12	38				
29	0	0	4	0	1	7	1	3	0	1	6	0	1	5	1	0	2	0	0	0	0	0	3	1	2	0	1	0	7			
30	12	2	42	2	5	67	0	0	1	41	26	12	22	35	32	14	20	0	6	16	17	14	19	5	51	16	45	3	0	91		
31	33	15	109	3	17	90	1	0	0	53	3	0	0	6	53	23	26	0	21	0	16	23	22	1	57	10	64	0	0	17	128	
32	36	11	363	83	172	284	13	13	0	188	121	11	18	108	161	46	195	28	22	0	62	67	293	8	198	31	228	1	6	28	70	620

Sites Number One, Two, and Three Combined

Observed value for the occurrence of each individual species and the expected values for the co-occurrence of any two species.*

Horizontal Matrix Index - Species Numbers 1-32

Vertical Matrix Index - Species Numbers 1-32

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	21	22	23	24	25	26	27	28	29	30	31	32								
1	92.0																			
2	3.2	42.0																		
3	40.6	18.5	530.0																	
4	13.4	6.1	77.3	175.0																
5	18.7	8.5	107.8	35.6	244.0															
6	53.7	24.5	309.6	102.2	142.5	701.0														
7	2.4	1.1	13.7	4.5	6.3	18.1	31.0													
8	1.2	.5	7.1	2.3	3.3	9.3	.4	16.0												
9	4.1	1.9	23.4	7.7	10.8	31.0	1.4	.7	53.0											
10	26.2	12.0	151.0	49.9	69.5	199.8	8.8	4.6	15.1	342.0										
11	32.5	14.8	187.3	61.8	86.2	247.7	11.0	5.7	18.7	120.8	424.0									
12	2.8	1.3	16.3	5.4	7.5	21.6	1.0	.5	1.6	10.5	13.1	37.0								
13	13.9	6.3	79.5	26.2	36.6	105.1	4.6	2.4	7.9	51.3	63.6	5.5	180.0							
14	29.6	13.5	170.5	56.3	78.5	225.5	10.0	5.1	17.0	110.0	136.4	11.9	57.9	386.0						
15	17.2	7.9	99.4	32.8	45.8	131.4	5.8	3.0	9.9	64.1	79.5	6.9	33.8	72.4	225.0					
16	4.8	2.2	27.4	9.0	12.6	36.2	1.6	.8	2.7	17.7	21.9	1.9	9.3	19.9	11.6	62.0				
17	20.9	9.5	120.1	39.7	55.3	158.9	7.0	3.6	12.0	77.5	96.1	8.4	40.8	87.5	51.0	14.1	272.0			
18	2.4	1.1	13.7	4.5	6.3	18.1	.8	.4	1.4	8.8	11.0	1.0	4.6	10.0	5.8	1.6	7.0	31.0		
19	2.7	1.2	15.5	5.1	7.1	20.4	.9	.5	1.5	10.0	12.4	1.1	5.3	11.3	6.6	1.8	7.9	.9	35.0	
20	13.4	5.1	77.3	25.5	35.6	102.2	4.5	2.3	7.7	49.9	61.8	5.4	26.2	56.3	32.8	9.0	39.7	4.5	5.1	175.0
21	8.1	3.7	46.8	15.5	21.6	61.9	2.7	1.4	4.7	30.2	37.5	3.3	15.9	34.1	19.9	5.5	24.0	2.7	3.1	15.5
	106.0																			
22	8.2	3.7	47.3	15.6	21.8	62.5	2.8	1.4	4.7	30.5	37.8	3.3	16.0	34.4	20.1	5.5	24.3	2.8	3.1	15.6
	9.5	137.0																		
23	35.8	16.3	206.3	68.1	95.0	272.8	12.1	6.2	20.6	133.1	165.0	14.4	70.0	150.2	87.6	24.1	105.9	12.1	13.6	68.1
	41.3	41.6	467.0																	
24	6.0	2.7	34.4	11.4	15.9	45.6	2.0	1.0	3.4	22.2	27.6	2.4	11.7	25.1	14.6	4.0	17.7	2.0	2.3	11.4
	6.9	7.0	30.4	78.0																
25	41.6	19.0	239.8	79.2	110.4	317.2	14.0	7.2	24.0	154.8	191.9	16.7	81.4	174.7	101.8	28.1	123.1	14.0	15.8	79.2
	48.0	48.4	211.3	35.3	543.0															
26	11.4	5.2	65.8	21.7	30.3	87.0	3.8	2.0	6.6	42.5	52.6	4.6	22.3	47.9	27.9	7.7	33.8	3.8	4.3	21.7
	13.2	13.3	58.0	9.7	67.4	149.0														
27	38.0	17.4	219.1	72.3	100.9	289.7	12.8	6.6	21.9	141.4	175.3	15.3	74.4	159.5	93.0	25.6	112.4	12.8	14.5	72.3
	43.8	44.2	193.0	32.2	224.4	61.6	496.0													
28	2.9	1.3	16.8	5.5	7.7	22.2	1.0	.5	1.7	10.8	13.4	1.2	5.7	12.2	7.1	2.0	8.6	1.0	1.1	5.5
	3.4	3.4	14.8	2.5	17.2	4.7	15.7	38.0												
29	.5	.2	3.1	1.0	1.4	4.1	.2	.1	.3	2.0	2.5	.2	1.0	2.3	1.3	.4	1.6	.2	.2	1.0
	.6	.6	2.7	.5	3.2	.9	2.9	.2	7.0											
30	7.0	3.2	40.2	13.3	18.5	53.2	2.4	1.2	4.0	25.9	32.2	2.8	13.6	29.3	17.1	4.7	20.6	2.4	2.7	13.3
	8.0	8.1	35.4	5.9	41.2	11.3	37.6	2.9	.5	91.0										
31	9.8	4.5	56.5	18.7	26.0	74.8	3.3	1.7	5.7	36.5	45.2	3.9	19.2	41.2	24.0	6.6	29.0	3.3	3.7	18.7
	11.3	11.4	49.8	8.3	57.9	15.9	52.9	4.1	.7	9.7	128.0									
32	47.5	21.7	273.8	90.4	126.1	362.2	16.0	8.3	27.4	176.7	219.1	19.1	93.0	199.4	116.3	32.0	140.5	16.0	18.1	90.4
	54.8	55.3	241.3	40.3	280.5	77.0	256.3	19.6	3.6	47.0	66.1	620.0								

CHI-SQUARE- 6194.91

*Directions for reading values from this table: When comparing any two species, the larger species number is found on the vertical matrix index. The smaller species number is found on the horizontal matrix index. Note that the horizontal index is truncated for species numbers larger than 20. Values for species 21-32 are read in columns 1-12 in the second line following the vertical index species number. As an example, the value expected for the co-occurrence of species numbers 27 and 28 is 15.7.