

10. The vowels of North American English: Maps of natural breaks in F1 and F2

Introduction

The 36 maps of this chapter will display the geographic distribution of differences in vowel quality for the 18 vowel classes defined in Chapter 2, as measured by F1 and F2 means, for the 439 Telsur subjects whose vowels have been analyzed acoustically. This chapter is designed to display geographic patterns in a uniform way with the minimum of theoretical interpretation. No isoglosses are superimposed upon the patterns that are displayed. Each map is accompanied by a brief note relating the most obvious patterns to the later chapters of the Atlas which deal with them.

The vowel means used here are calculated with the following restrictions, designed to separate allophones that are radically different from the main distribution: vowels before liquids or after glides and obstruent/liquid clusters are excluded. For the vowels /i, e, æ, aw/, tokens before nasal consonants are excluded. In addition, certain phonemes are divided into specific allophones. The class of /æN/ represents all tokens of /æ/ before nasal consonants, while /æ/ represents tokens in non-nasal environments. The class /Tuw/ represents all /uw/ tokens after coronal consonants, and /Kuw/ represents /uw/ tokens after non-coronal consonants. The final two classes, /ahr/ and /ohr/, may be considered allophones of /ah/ and /oh/. /ah/ is not mapped in this series, since the Telsur data on /ah/ is not sufficient in quantity to support a presentation comparable to that of the other vowels. The means for /ay/ do not include vowels before voiceless consonants; the difference in the height of voiced and voiceless consonants is registered in Map 10.37. A comparable map for the height differential of /aw/ is given in Map 10.38.

The maps will follow in pairs, one for F1 and one for F2 for each vowel. The method for displaying vowel quality differences is the same for each pair. A thematic map is created for each set of 439 values, divided into four ranges by the “Natural Break” algorithm of the Mapinfo system. As defined by Mapinfo,

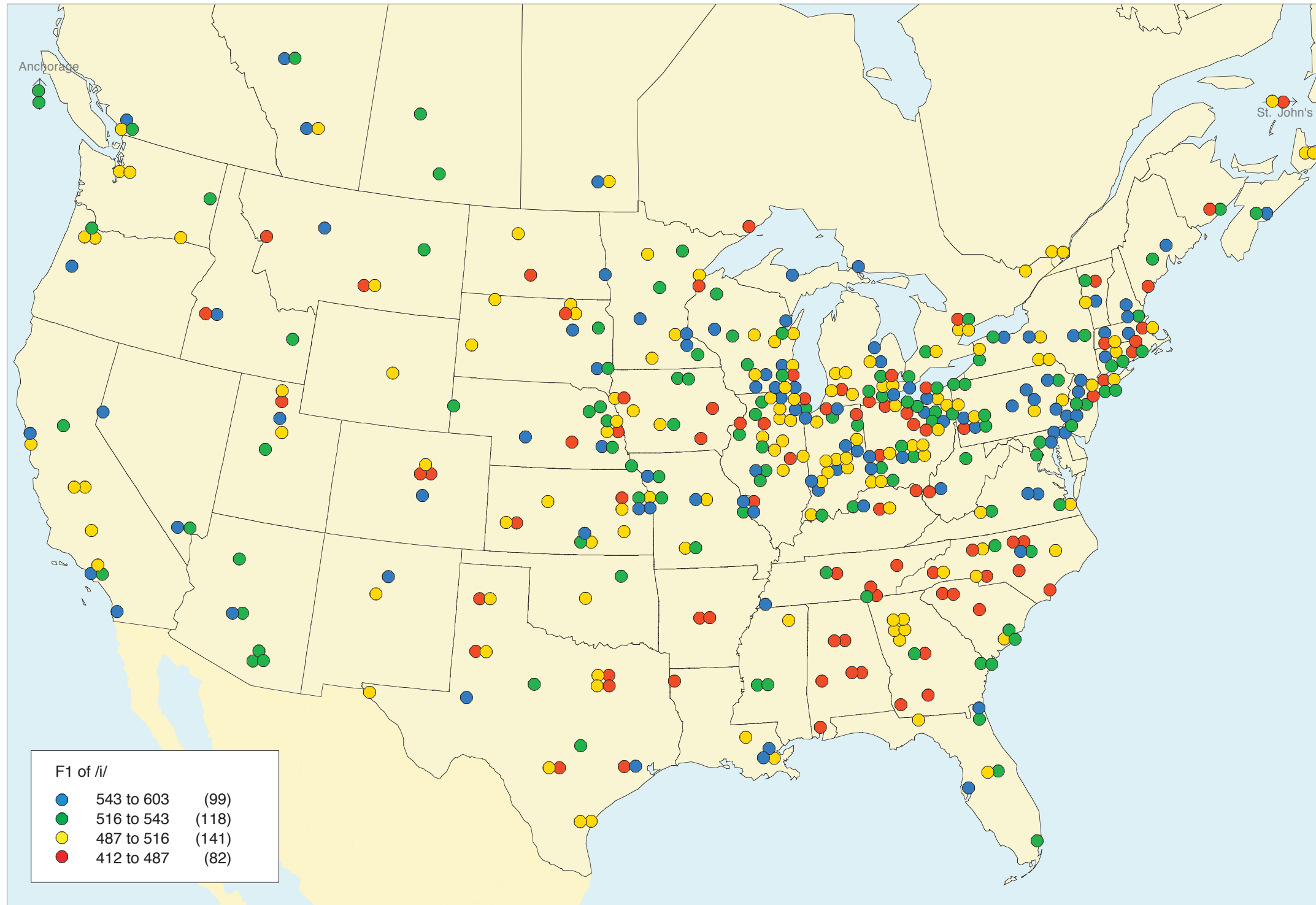
The range breaks are determined according to an algorithm such that the difference between the data values and the average of the data values is minimized on a per range basis

Four colors are used. For F1, the colors are arranged from lowest to highest in the order red, yellow, green, and blue, so that red represents the highest vowel and blue the lowest. Thus Map 10.5 for the F1 of /æ/ shows a heavy concentration of red circles in the Great Lakes region, indicating the general raising of short-*a* that is the triggering event of the Northern Cities Shift.

For F2, the colors are arranged from highest to lowest in the order red, yellow, green, and blue (the opposite order from F1), so that red represents the frontest vowel and blue the farthest back. Map 10.2 for the F2 of /i/, for example, shows a heavy concentration of blue symbols in the Great Lakes region, indicating the backing of /i/ that is associated with the Northern Cities Shift.

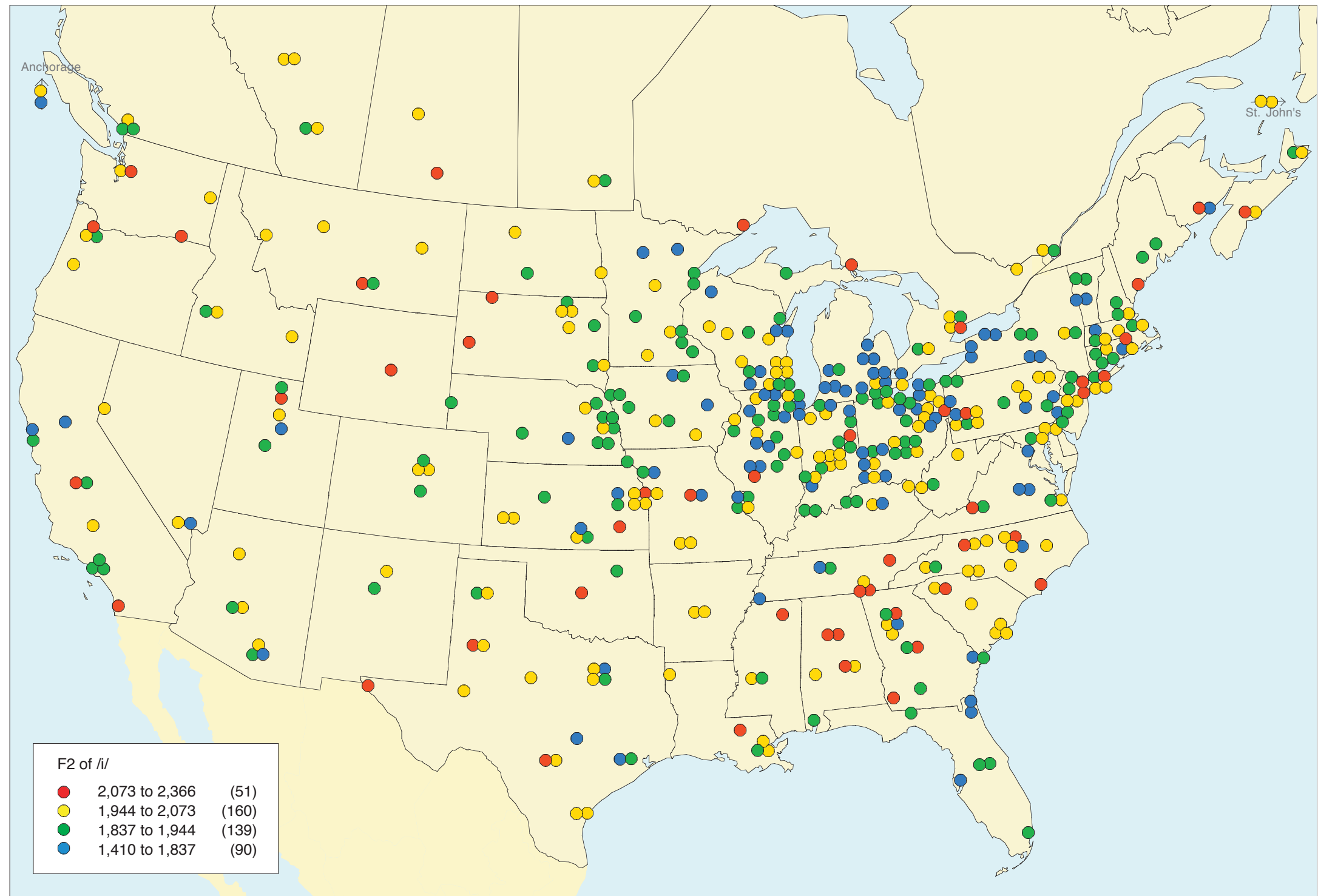
On all legends, the number of tokens are indicated in parentheses. On most maps, the total number of subjects is 440, rather than 439, since at this stage of the analysis one speaker was included who was afterwards found not to satisfy all requirements for a Telsur subject.





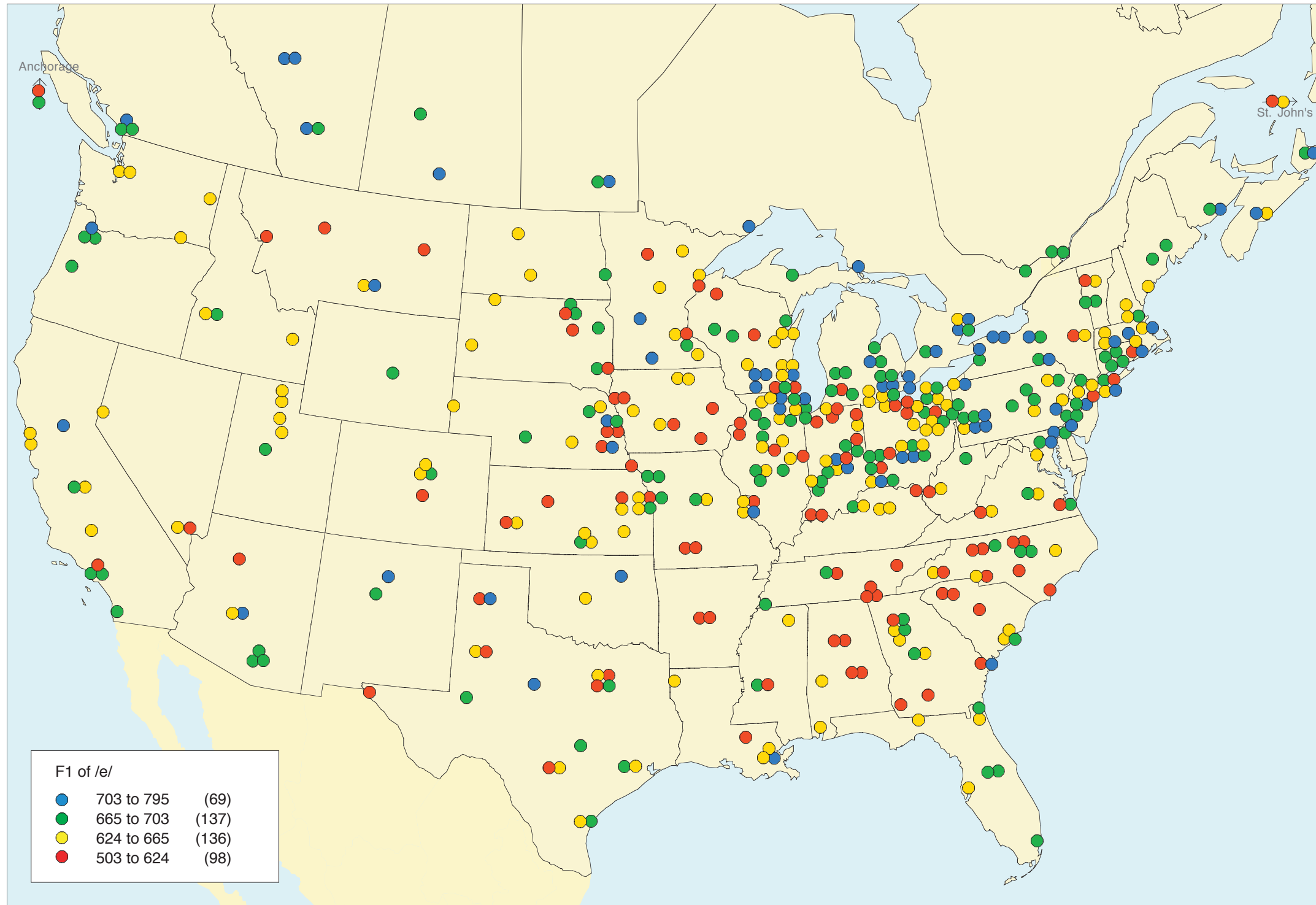
Map 10.1. The relative height (F1) of /i/ in *bit*, *hid*, etc.

No striking regional grouping by the height of /i/ is found except in the South, where the concentration of red symbols indicates a shift of /i/ to higher position. This is the third stage of the Southern Shift (Figure 11.2, Map 11.3). On the other hand, the blue circles representing relatively low /i/ are clustered in the mid-Atlantic states in a belt extending westward through the Midland.



Map 10.2. The relative fronting and backing (F2) of /i/ in *bit*, *hid*, etc.

The concentration of front values of /i/ in the inland South is parallel to that seen in Map 10.1, an integral element of the Southern shift. The heavy clustering of blue circles around the Great Lakes region registers a backing of /i/ that is closely associated with the Northern Cities Shift though not an essential part of it (Figures 14.11–12).

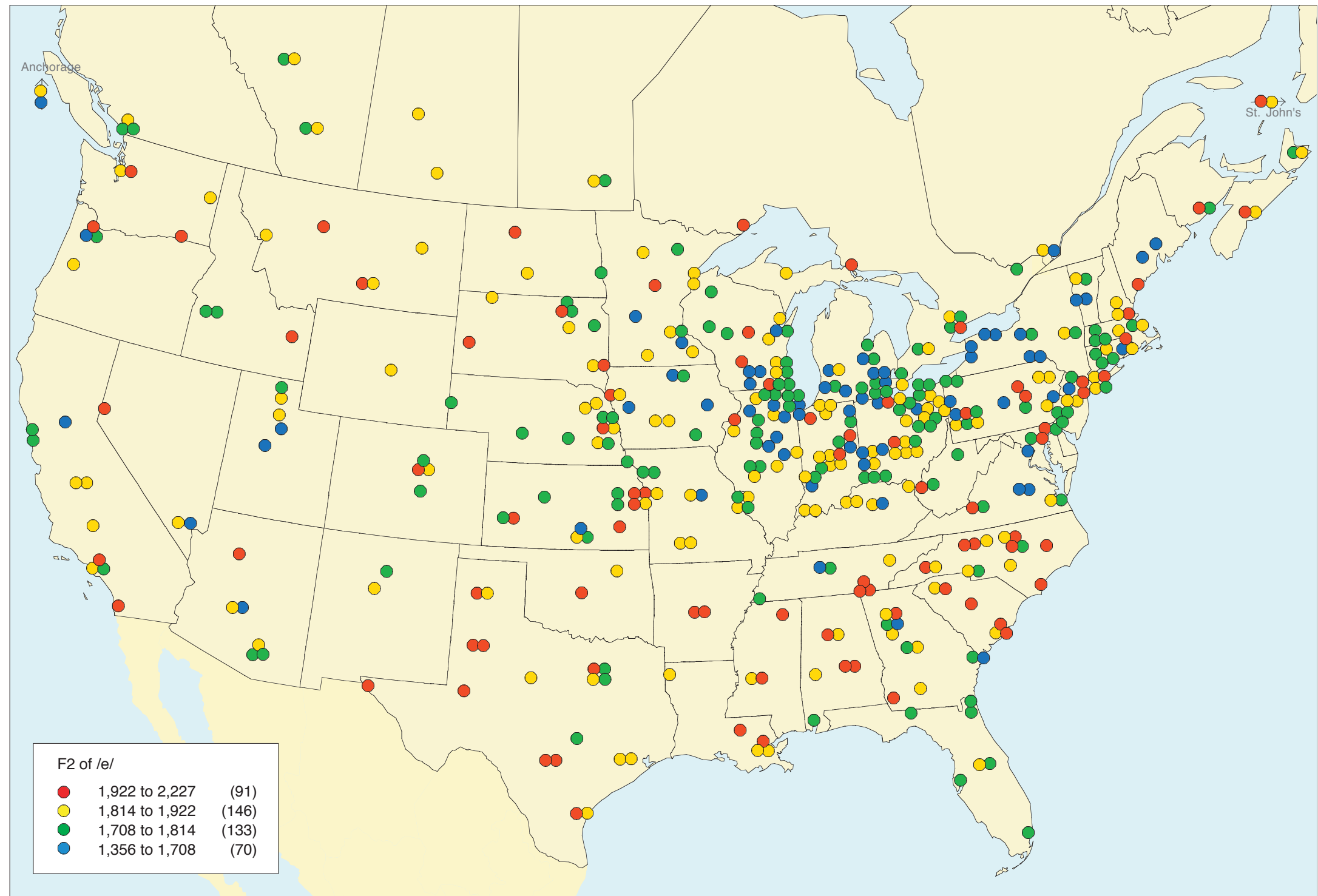


Map 10.3. The relative height (F1) of /e/ in *bet*, *bed*, etc.

The concentration of red circles in the South is similar to that of Map 10.1, but somewhat more extended. The raising of short /e/ is an element in the second stage of the Southern Shift (Figure 11.2, Map 11.3). One can also note an opposition of blue circles around the Great Lakes, representing a lowering of /e/

vs. a concentration of red and yellow symbols, representing raised /e/ in northern Indiana and Ohio. The lowering of /e/ was an early stage in the Northern Cities Shift (Figures 14.11–12).

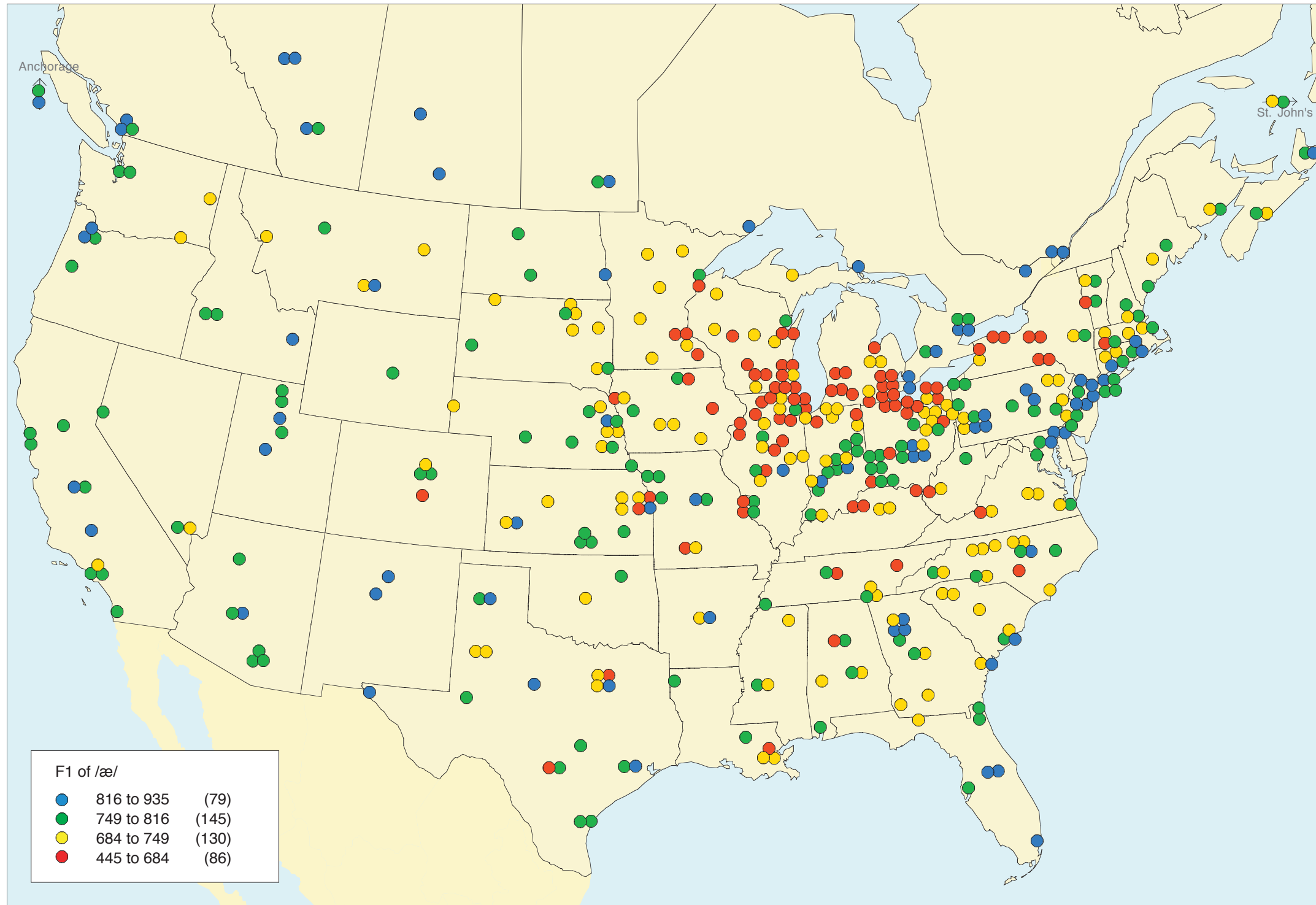




Map 10.4. The relative fronting and backing (F2) of /e/ in *bet*, *bed*, etc.

The grouping of red tokens in the Southern States is even more striking than in Maps 10.1–10.3 and extends further west into Texas. The fronting of /e/ to the peripheral track is an essential element of the second stage of the Southern Shift (Chapters 11, 18). On the other hand, the concentration of blue (and green) symbols in the Great Lakes Region is also more striking, reflecting the backing of /e/

which is now a prominent feature of the Northern Cities Shift. The blue symbols extend to western New York State, which is an integral part of the Inland North dialect area (Chapter 14). Blue and green symbols predominate in Canada as a result of the Canadian Shift (Figure 15.1, Map 15.4).

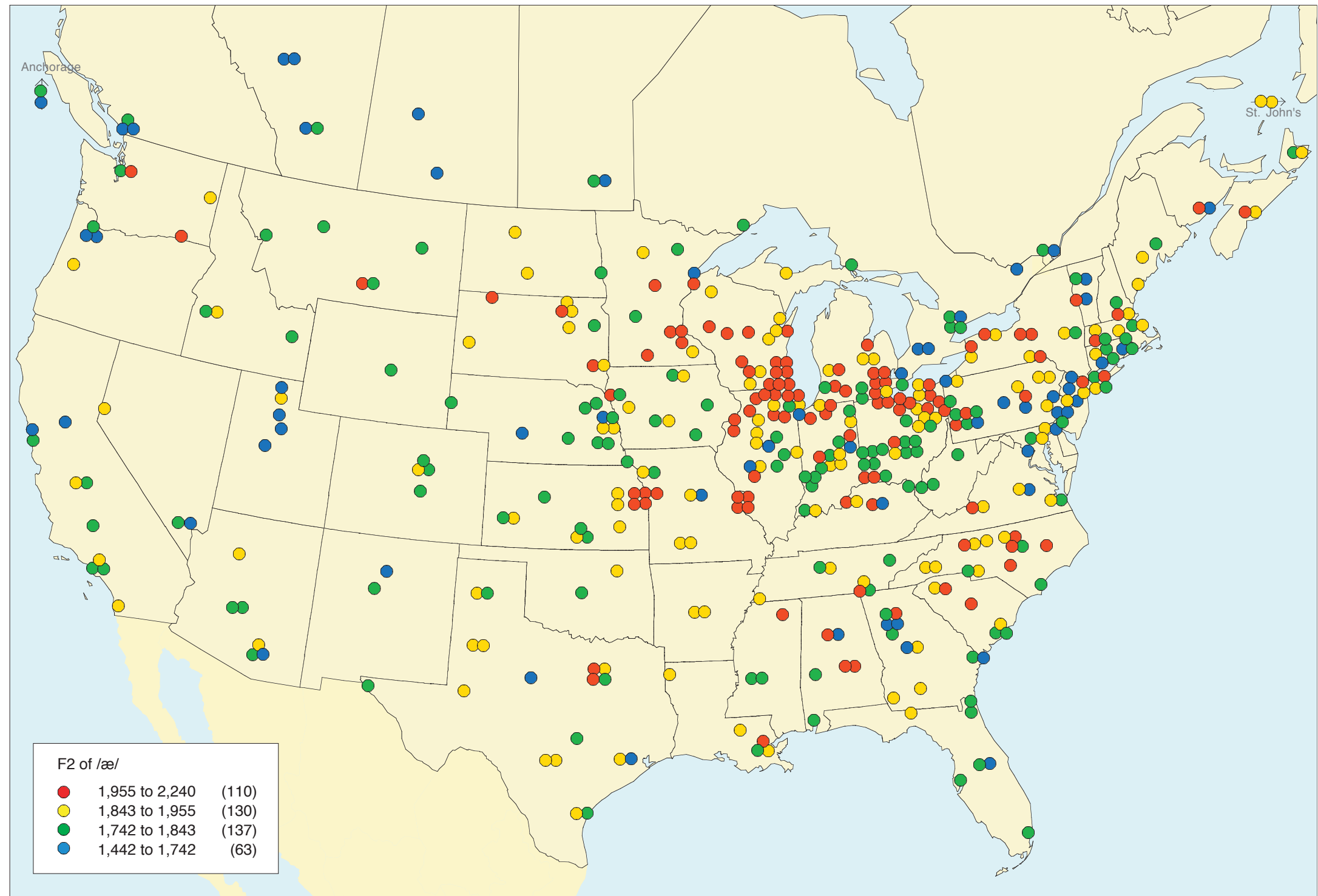


Map 10.5. The relative height of /æ/ in *bat*, *bad*, etc.

The mean values of /æ/ here do not include /æ/ before nasals in *man*, *ham*, *Spanish*, etc., since these vowels are raised in almost all areas of North America. The strong clustering of red circles defines the Inland North, extending from southeastern Wisconsin to New York State. The general raising of /æ/ is the first stage

of the Northern Cities Shift (Figure 13.7, Maps 14.3 and 14.4). The heavy grouping of blue circles in the New York City and Mid-Atlantic area reflects the split of /æ/ into tense and lax phonemes in this region. This map shows the lax phoneme, which is not raised.

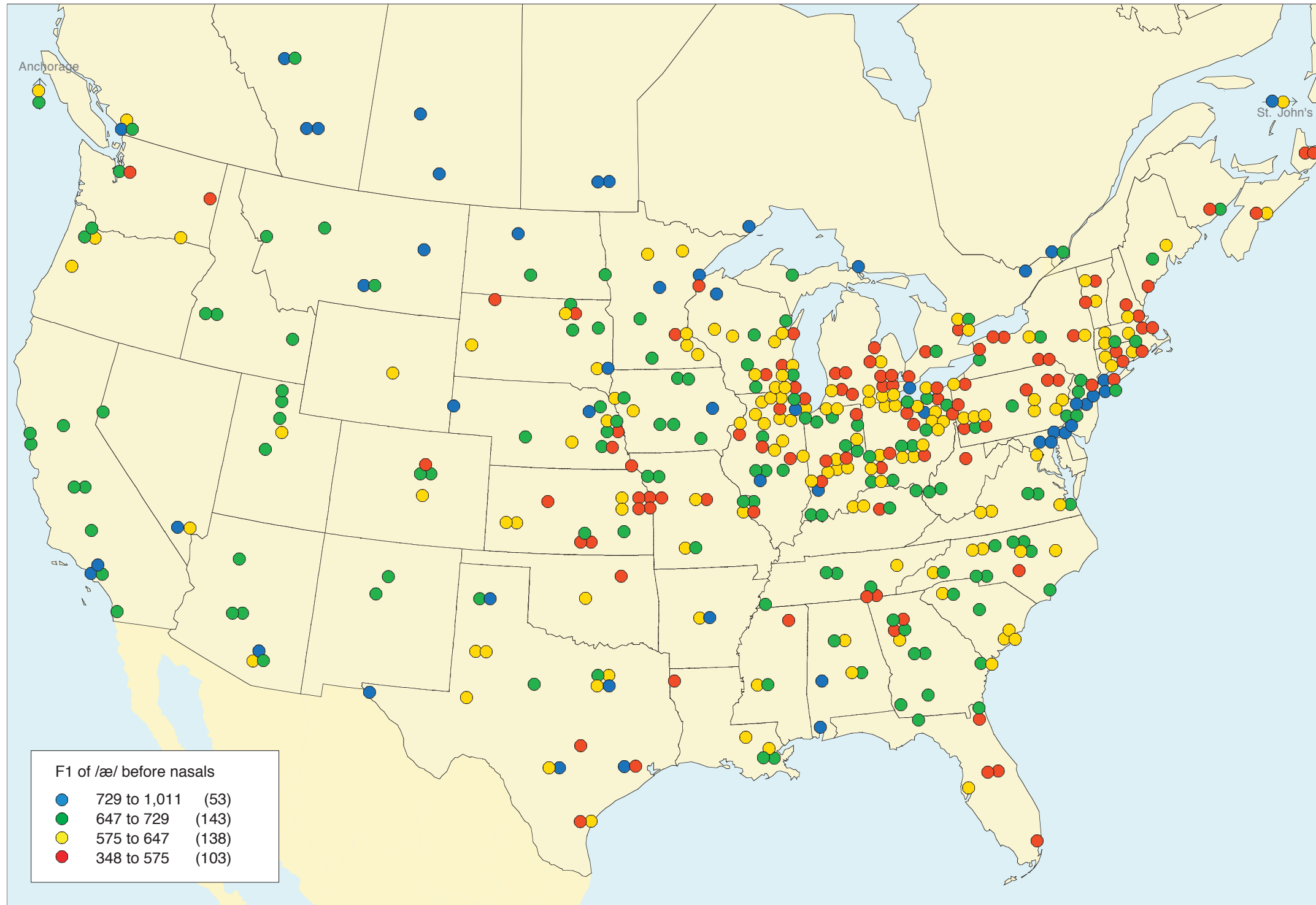




Map 10.6. The relative fronting and backing of /æ/ in *bat*, *bad*, etc.

This distribution is very similar to that of Map 10.5, since the raising of /æ/ is generally accompanied by fronting along the front peripheral track. However, the red circles indicating extreme fronting extend to St. Louis and Kansas City in a much more pronounced way than in Map 10.5. The preponderance of blue

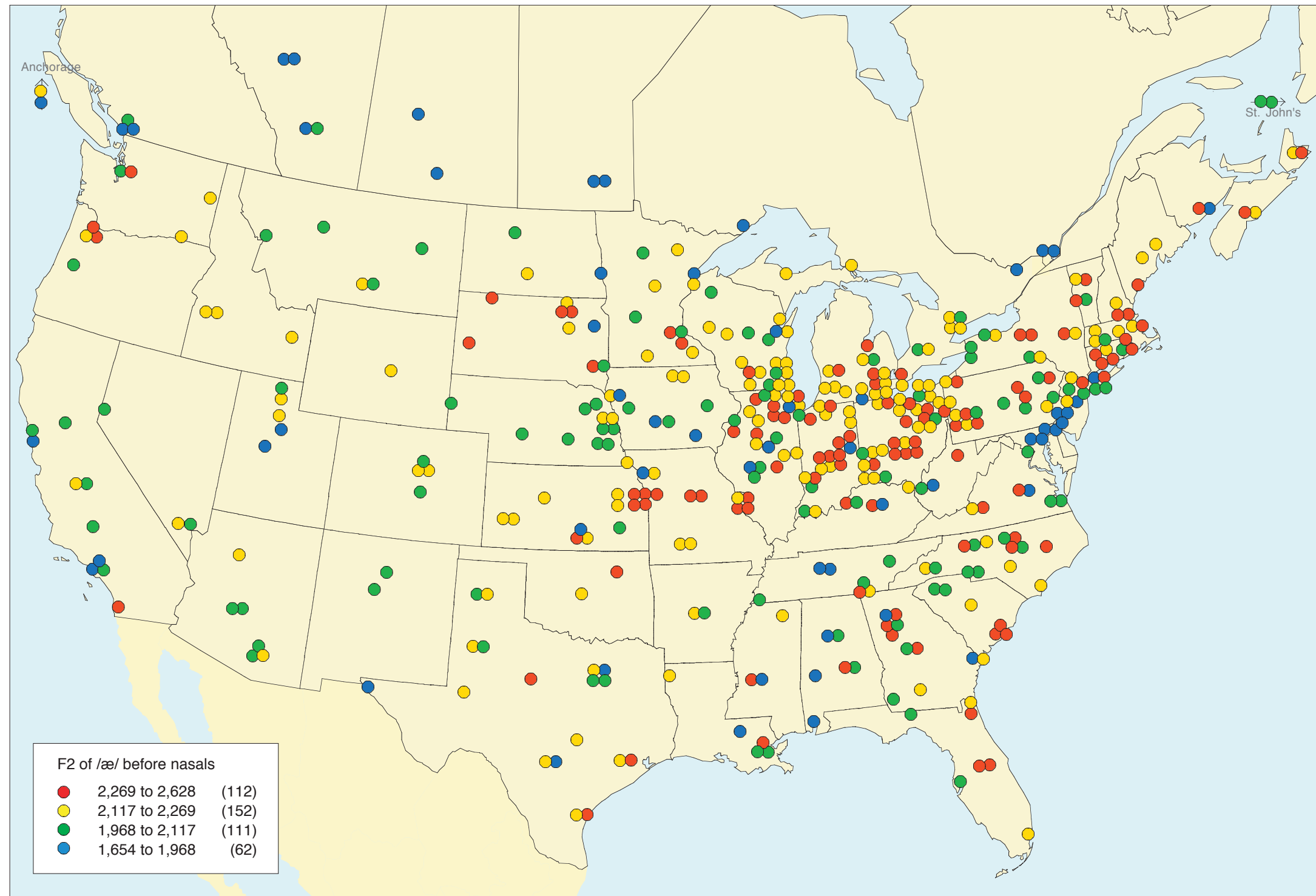
symbols in western and central Canada reflects the Canadian Shift (Figure 15.1, Map 15.4). The backward movement of /æ/ is more prominent than lowering in this chain shift.



Map 10.7. The relative height of /æ/ before nasals in *man*, *ham*, *Spanish*, etc.

The concentration of red symbols in the Northern area is similar to that of Map 10.5, indicating that raising of /æ/ before nasals is a more general phenomenon than raising before oral consonants (Chapter 13). Canada (excluding the Atlantic

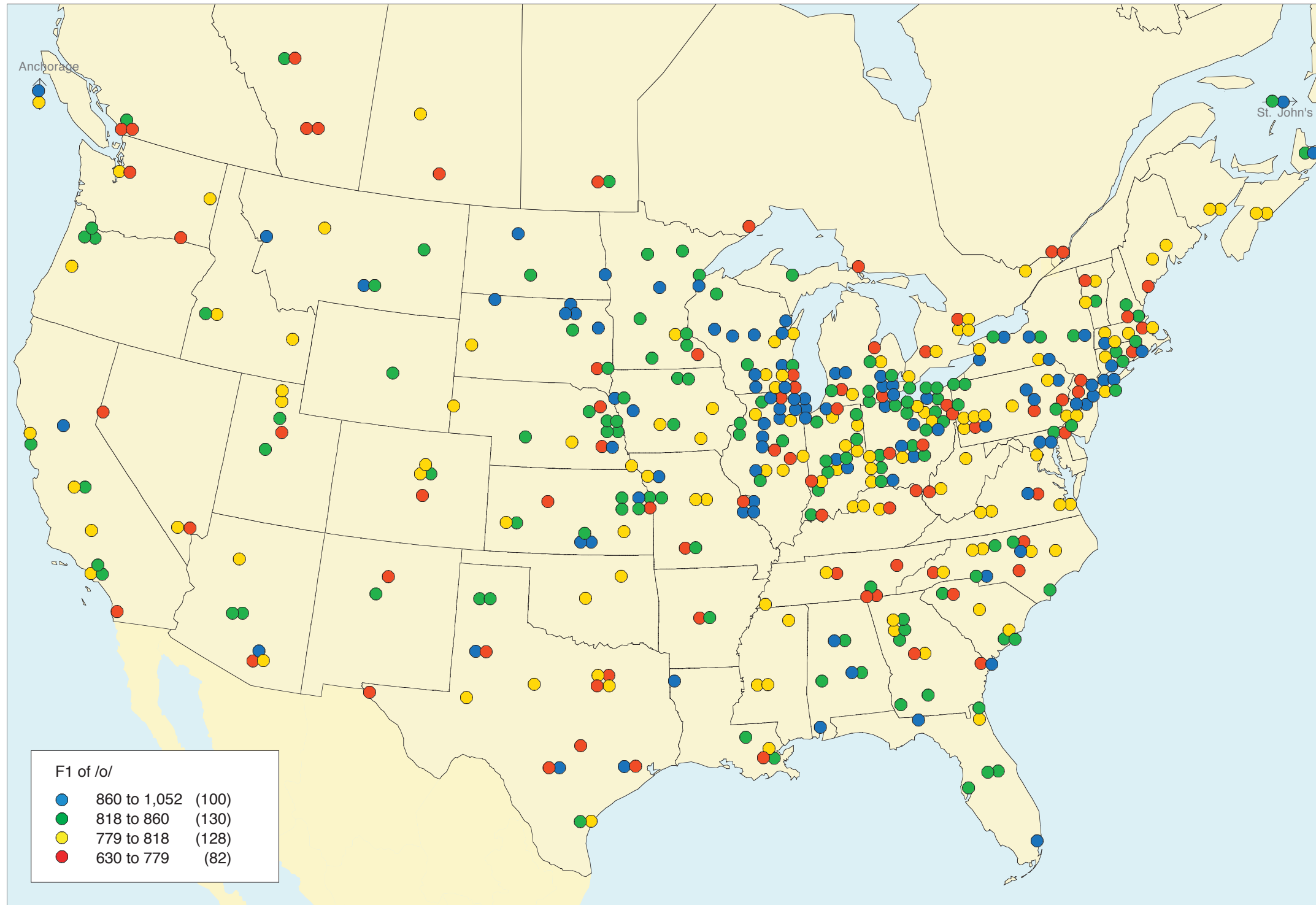
Provinces) shows almost exclusively blue symbols, indicating minimal raising in this environment. The blue circles in the Mid-Atlantic states again reflect the fact that the raised vowels are re-assigned to the tense phoneme /æh/.



Map 10.8. The relative fronting and backing of /æ/ before nasals in *man*, *ham*, *Spanish*, etc.

The overall pattern of Map 10.8 is more diffuse than that of Maps 10.5–10.7. Red circles are well represented in New England and the Midland, where the nasal system of short-*a* raising is found (raising before all and only before nasals; see Map 13.3, Figure 13.6). Red circles are diffusely spread across the North, since the fronting of /æ/ before nasals is not as distinctive a feature of the North as is the fronting of /æ/ in general. The westward extension of red circles to St. Louis, Co-

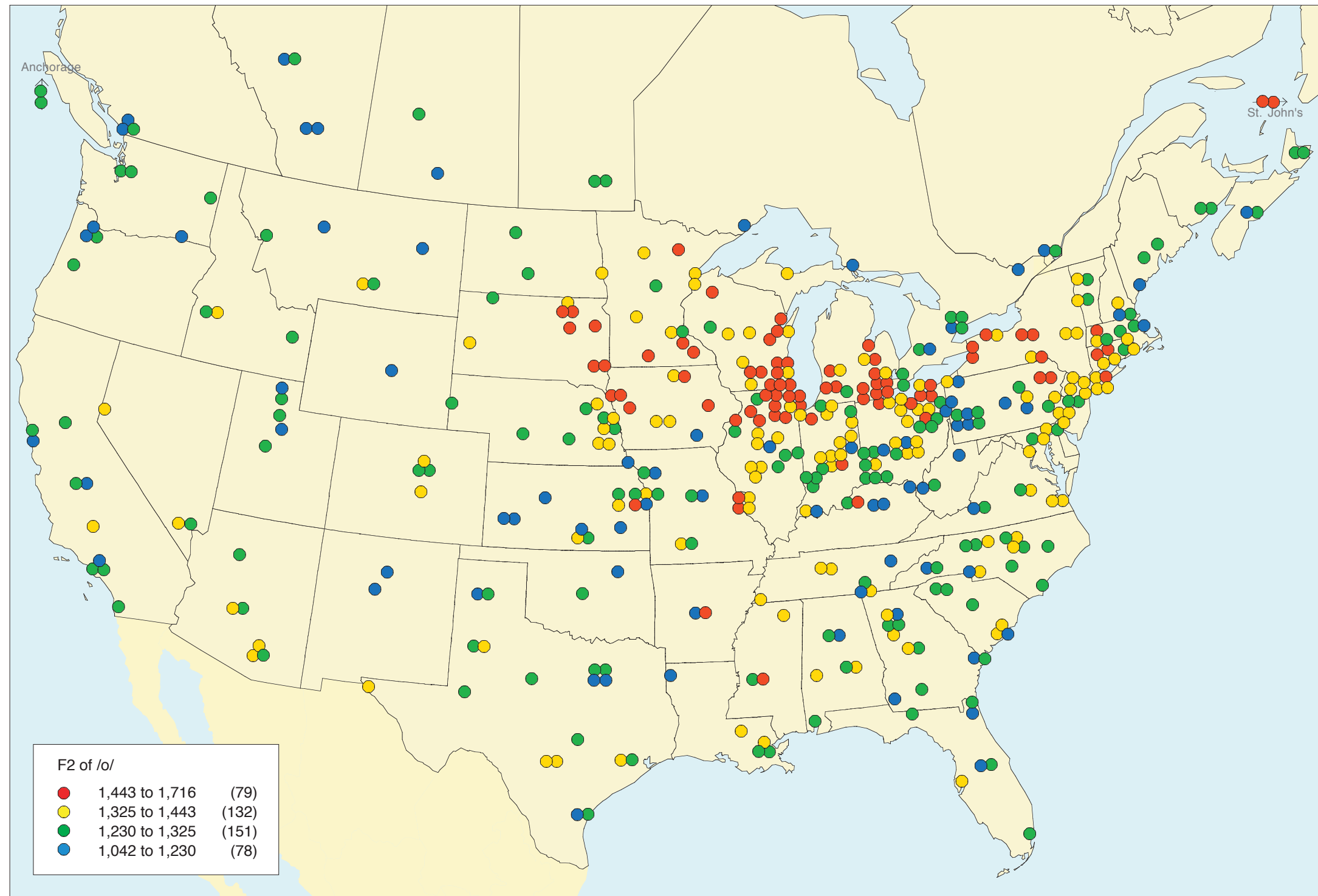
lumbia, and Kansas City is striking, as in Map 10.6. The Canadian concentration of blue (less fronted) symbols is even more striking than in Map 10.7. The blue circles in the Mid-Atlantic states reflect the split of short-*a*. For the Mid-Atlantic states, this map shows the lax pre-nasal subclass of words like *Spanish*, not the tense subclass of words like *ham*.



Map 10.9. The relative height of /o/ in *hot*, *god*, etc.

This map does not show a strong concentration of any one natural group, since dialect variation in /o/ tends to involve advancement rather than height. There is a tendency to find lower (blue) vowels in the North and higher vowels (red) in Canada and the West, reflect the height of /o/ is not a marked trait of any one

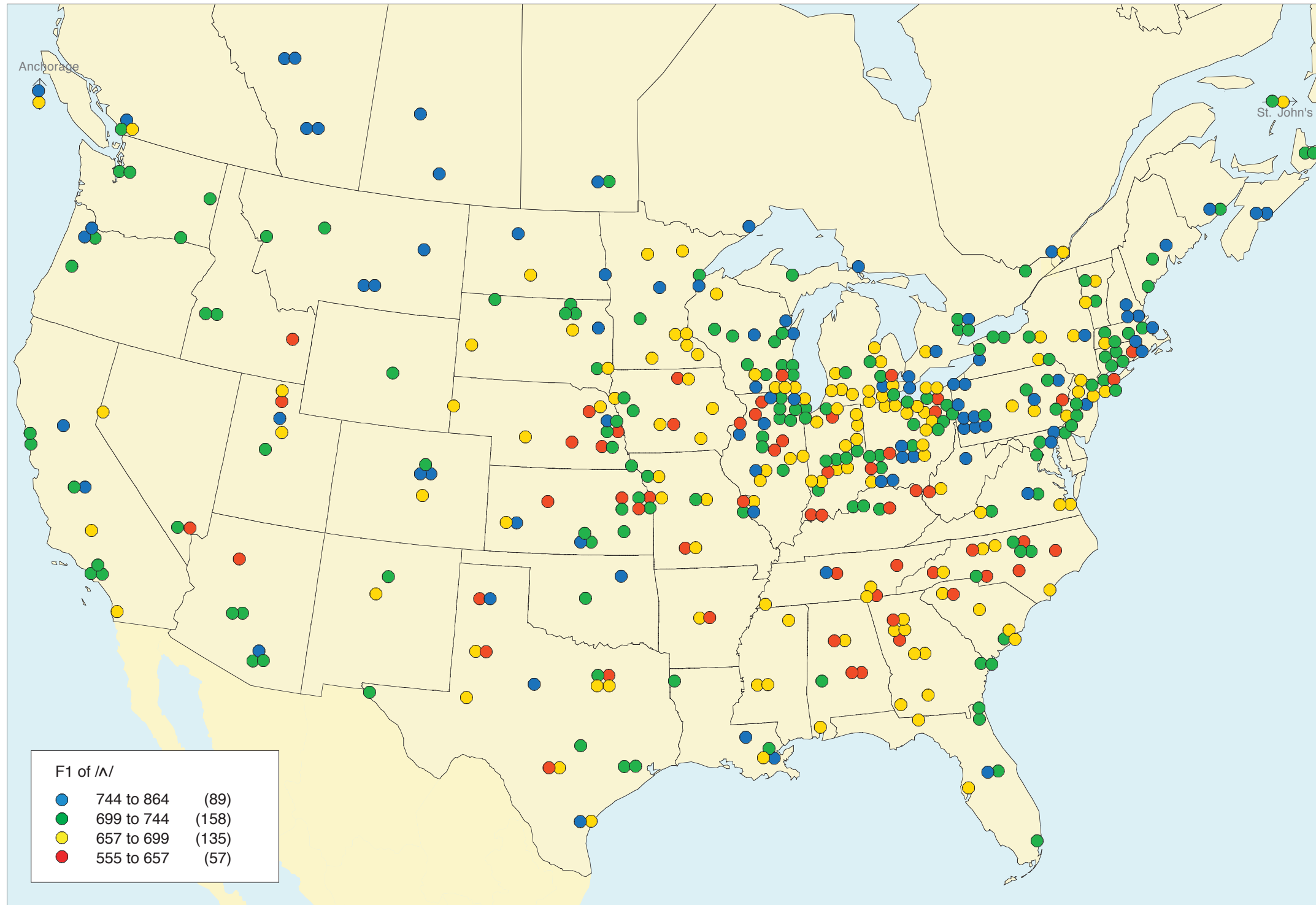
dialect area. The raising and backing of /o/ when it merges with /oh/ in the low back merger (Chapter 9). On the whole, the height of /o/ is not a distinguishing trait of any dialect area.



Map 10.10. The relative fronting and backing of /o/ in *hot*, *god*, etc.

The strong concentration of red symbols in the North – particularly the Great Lakes region and New York State – reflects the fronting of /o/ that forms the second stage of the Northern Cities Shift (Chapter 14). This extends further west than many other elements of the shift, reaching as far as South Dakota. Moderately front forms of /o/ (yellow circles) predominate in the Mid-Atlantic States

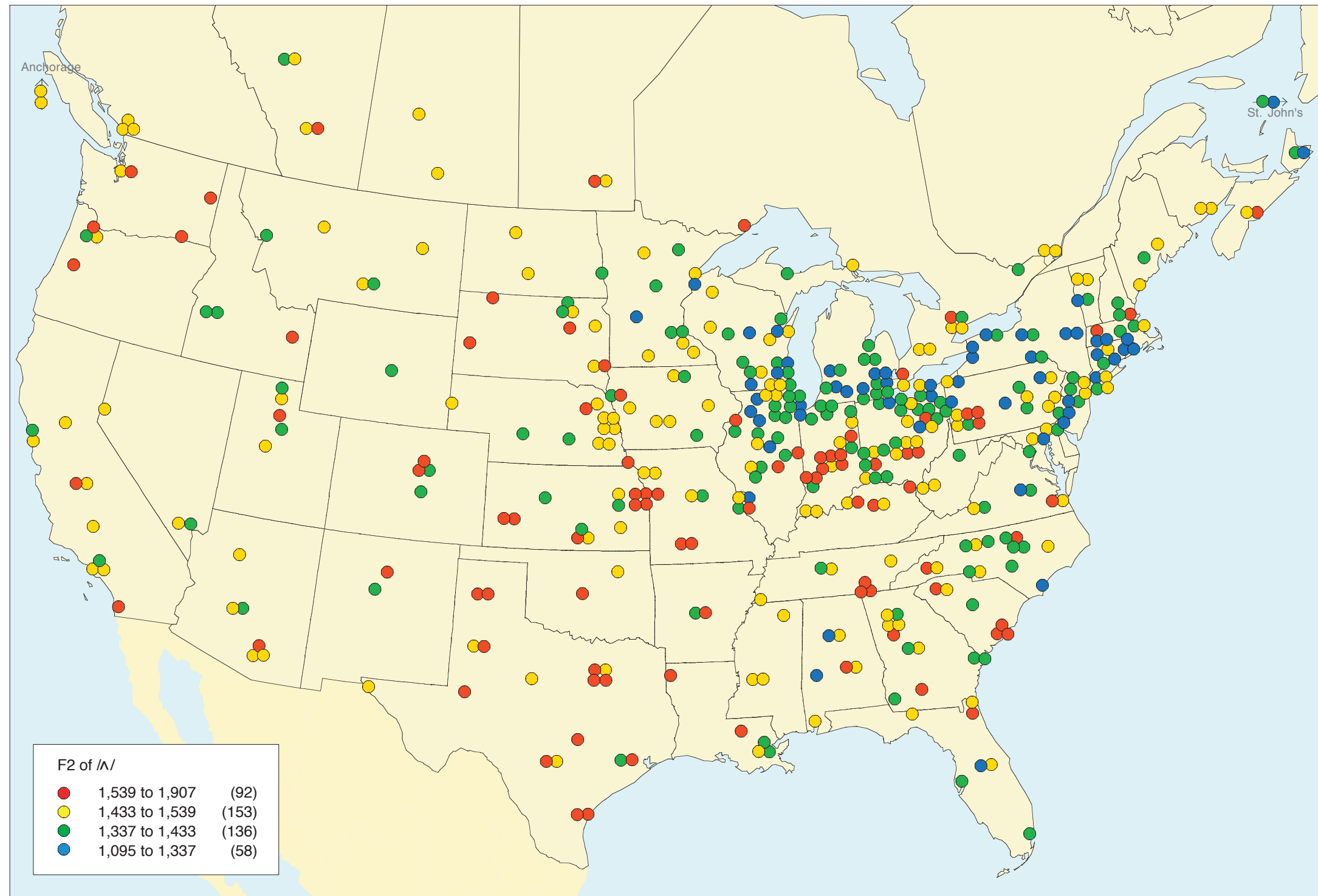
and the Midland area of Illinois, Indiana, and Ohio. This is opposed to the predominance of blue and green in the South, West, and Canada, reflecting a low back position for this phoneme, whether or not it is merged with /oh/. St. John's, Newfoundland, is a noteworthy exception to the Canadian pattern, with a fronted /o/ comparable to that of the Inland North.



Map 10.11. The relative height of /ʌ/ in *but*, *run*, etc.

The height of /ʌ/ has not been the focus of any major dialect study so far. However, blue symbols indicating relatively low realizations of /ʌ/ are concentrated in Canada and neighboring North Central areas and in the city of Pittsburgh in

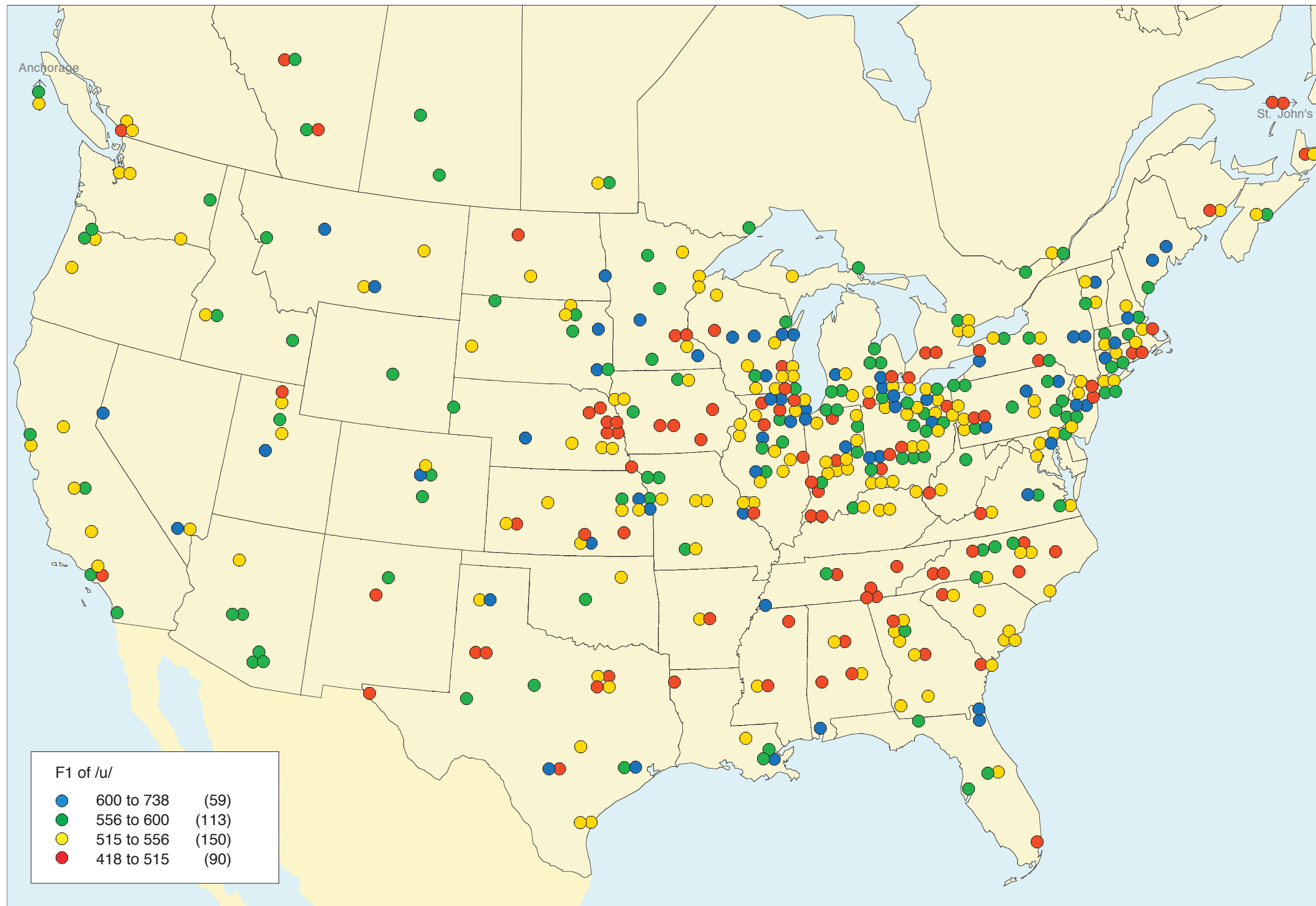
Western Pennsylvania. The lowering of /ʌ/ is in fact a central feature of the Pittsburgh chain shift (Figures 19.6-19.9). There may be a relation between the low back merger in these areas and a tendency for /ʌ/ to lower.



Map 10.12. The relative fronting and backing of /ʌ/ in *but, run, etc.*

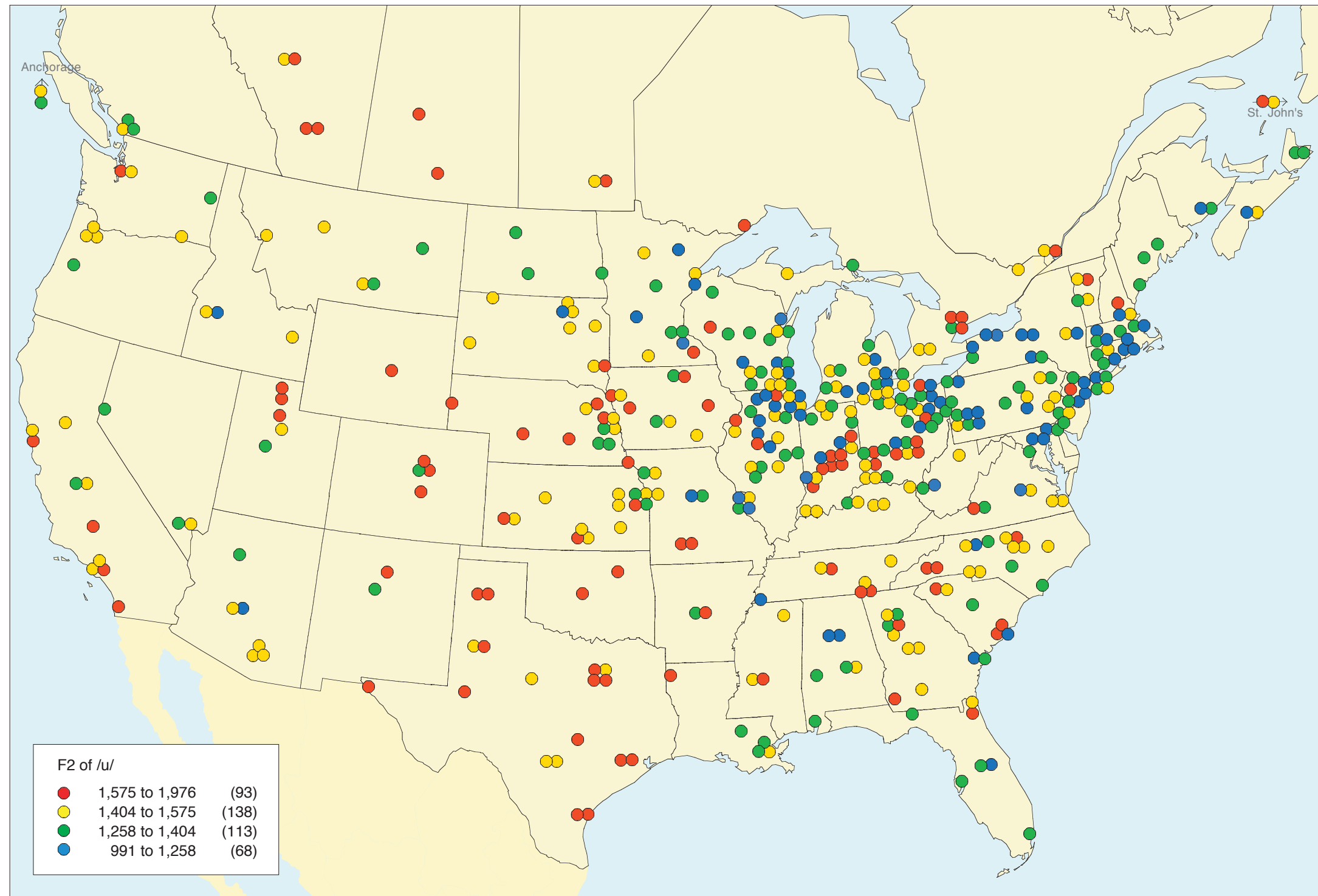
The fronting and backing of /ʌ/ shows considerable regional diversity. The backer versions of this phoneme (blue symbols) are almost entirely confined to the Inland North, in the Great Lakes region, New York State, and southern New England. This is the most recent stage of the Northern Cities Shift (Map 14.8, Figure

14.7). On the other hand, a forward movement of /ʌ/ is a characteristic feature of the Midland and the South, indicated by the red symbols. In Canada, Cape Breton and Newfoundland are clearly distinguished by a retracted variant of /ʌ/, versus more central values elsewhere.



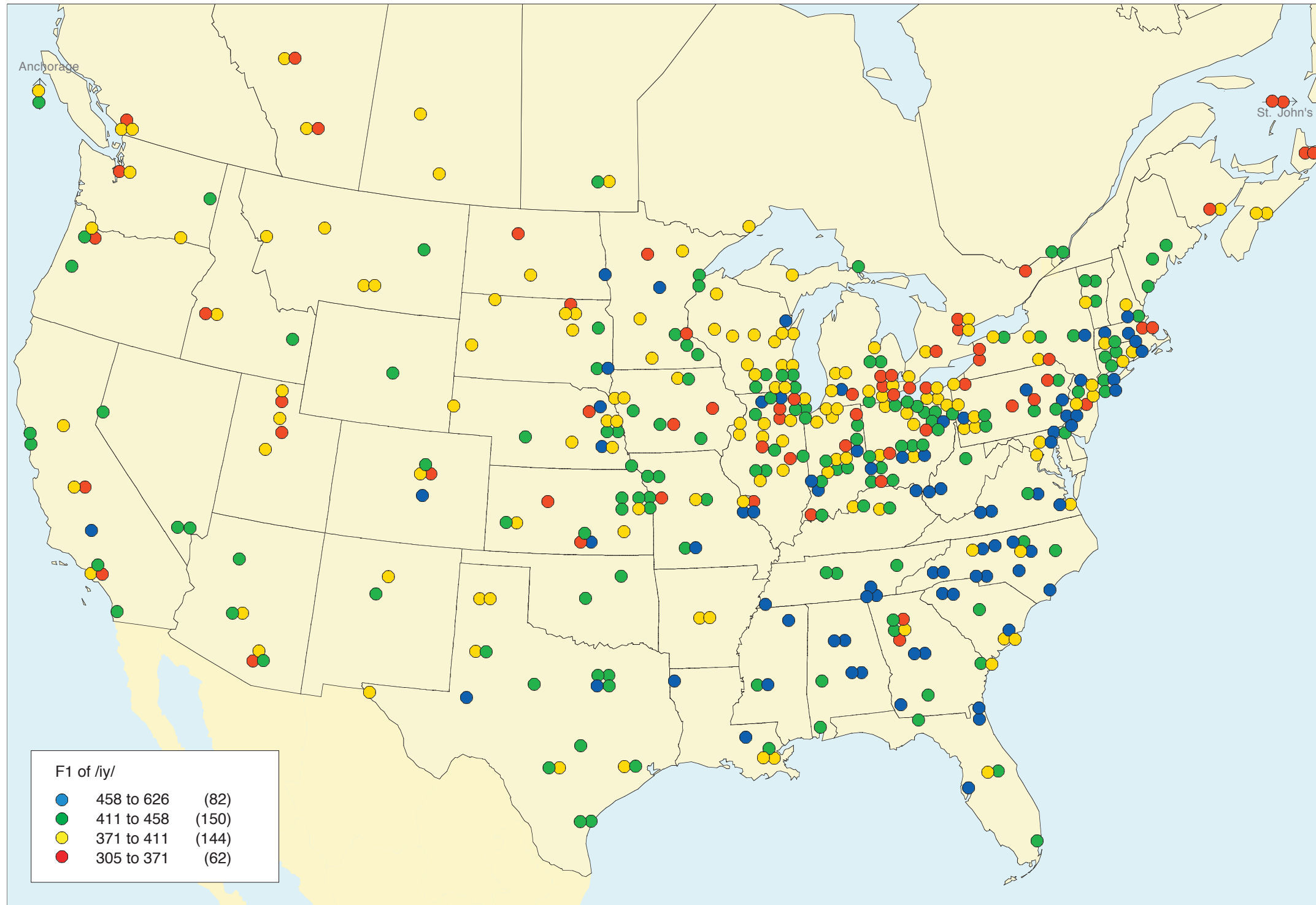
Map 10.13. The relative height of /u/ in *put*, *good*, etc.

The red circles representing relatively high realizations of /u/ are fairly well concentrated in the eastern half of the U.S. (and the Atlantic Provinces of Canada). The height of /u/ does not play a prominent part in any of the sound changes discussed in the Atlas, but is not without some regional correlates, as shown here.



Map 10.14. The relative fronting and backing of /u/ in *put*, *good*, etc.

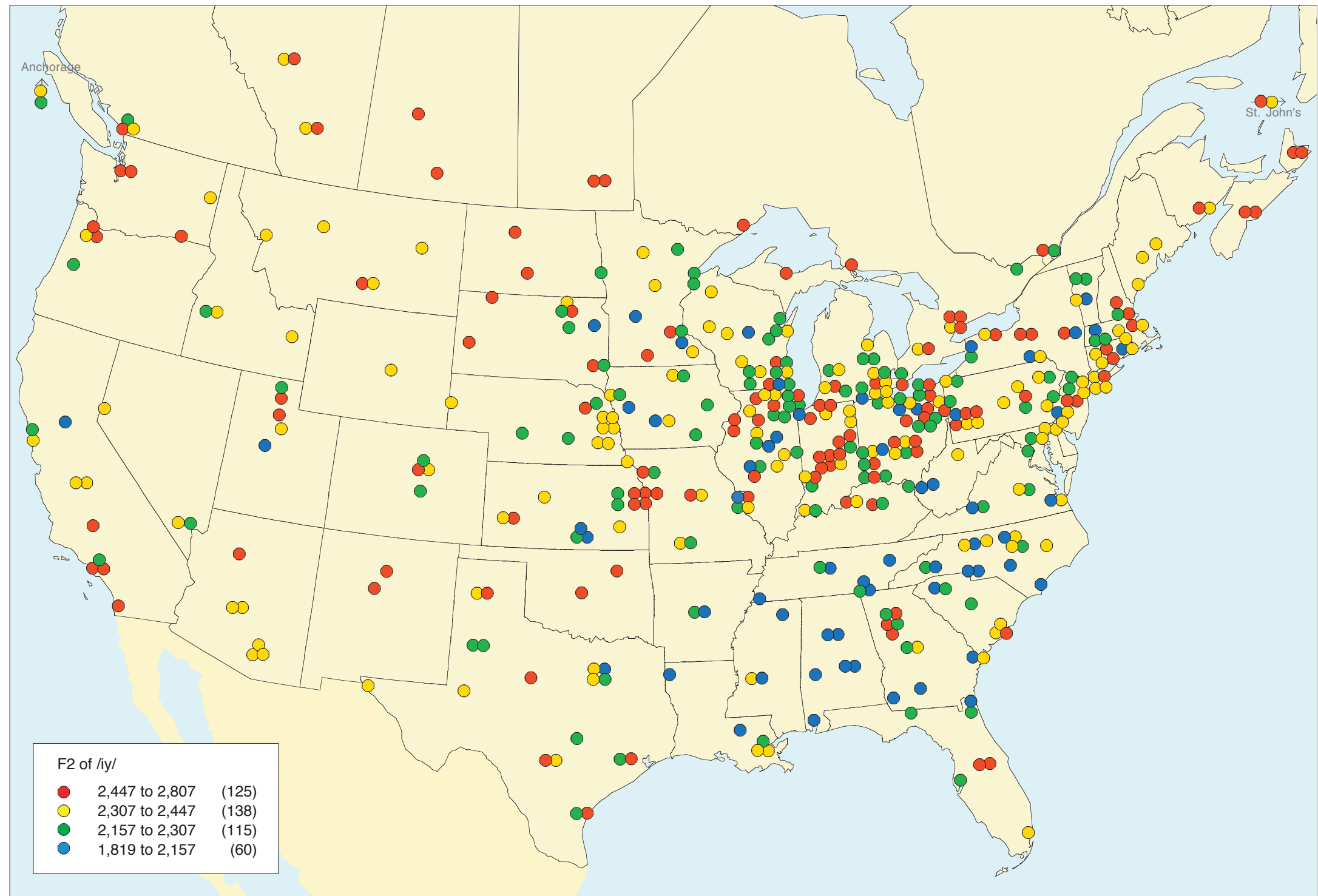
The blue symbols representing the backest forms of /u/ are almost entirely confined to a continuous area in the North: the Inland North, the Mid-Atlantic states, and southern New England. The red circles indicating the opposite tendency are not so heavily concentrated, but are found almost everywhere else except for the North Central and most of the Pacific Northwest areas.



Map 10.15. The relative height of /iy/ in *seat*, *seed*, *see*, etc.

The major grouping on this map is the concentration of blue symbols in the South and the southern Mid-Atlantic region. This is a second aspect of the third stage of the Southern Shift (Figure 11.2, Map 11.3). The lowering of /iy/ along a non-

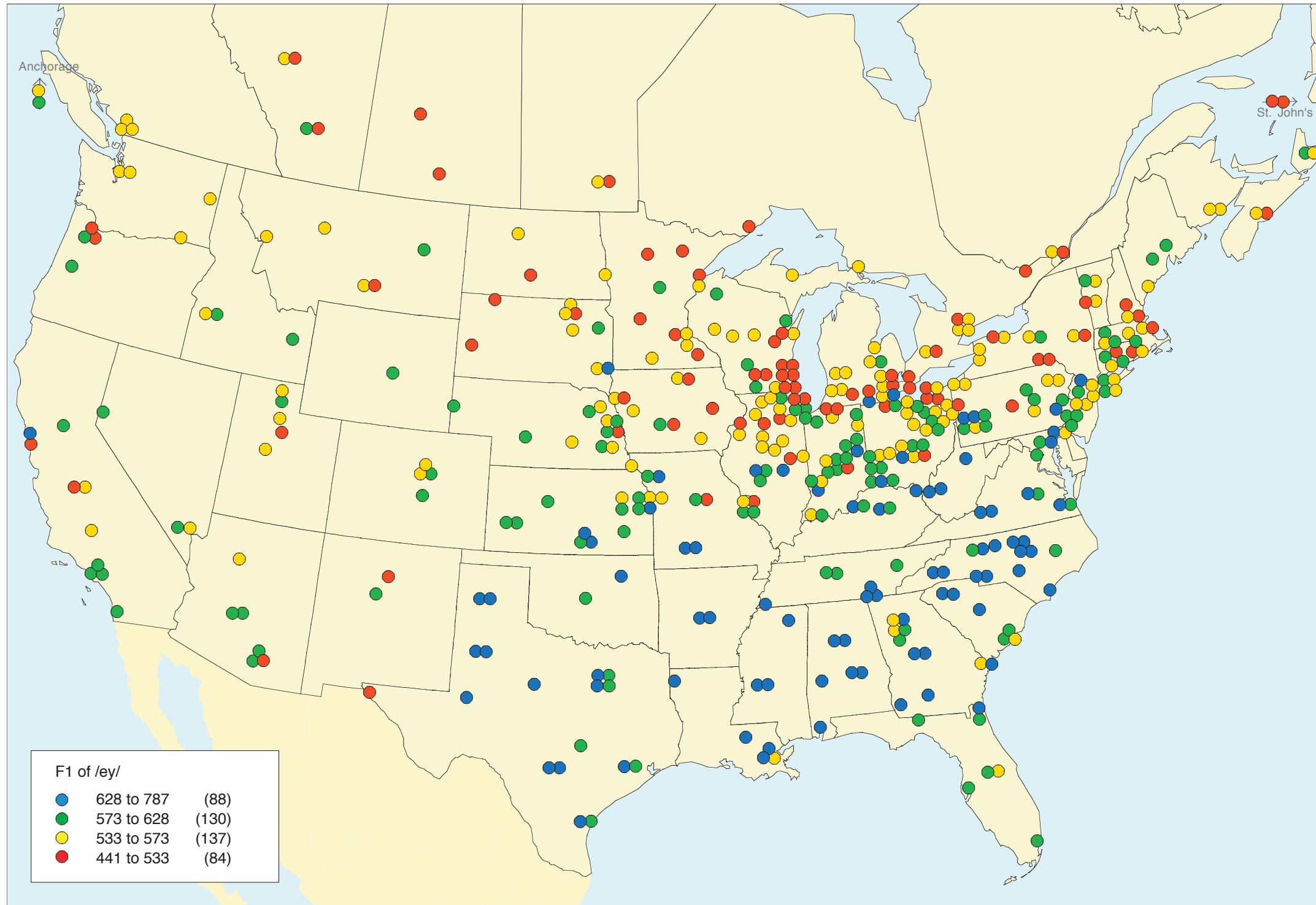
peripheral track is correlated with the opposing movement of /i/ in Map 10.1. In Canada, Cape Breton and Newfoundland are distinguished by consistently high variants of /iy/.



Map 10.16. The relative fronting and backing of /iy/ in *seat*, *seed*, *see*, etc.

The same clustering of blue symbols in the South can be observed here as in Map 10.15: the centralization of /iy/ accompanies its lowering along the non-peripheral track in the front vowel space. The opposite tendency – for /iy/ to oc-

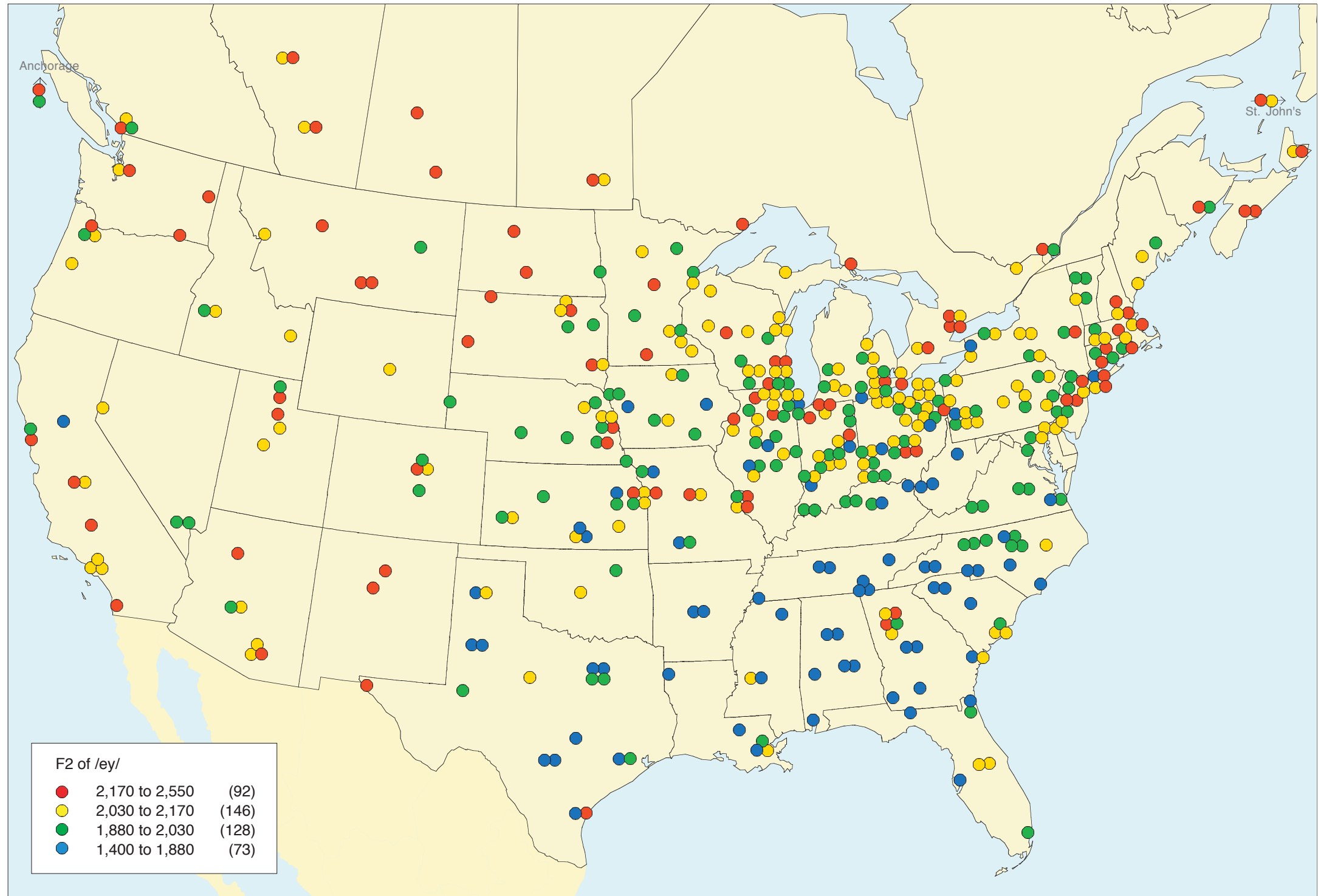
cupy a peripheral front position – is signaled by red symbols, which are scattered through most other dialect areas. Canada shows almost a uniform array of red circles, with only a few exceptions.



Map 10.17. The relative height of /ey/ in *bait*, *made*, *may*, etc.

This map shows a three-way regional division. Blue symbols, indicating the lowering of the nucleus of /ey/, predominate in the South, and red symbols, indicating raised /ey/, predominate in the North and Canada. In between are the intermediate yellow and green symbols, which predominate in the West, the Midland, and

the Mid-Atlantic states. The low vowels in the South are an aspect of the second stage of the Southern Shift, the downward movement of /ey/ that is the counterpart of the upward movement of /e/ in Map 10.3 (see Map 11.3, Figure 11.2).

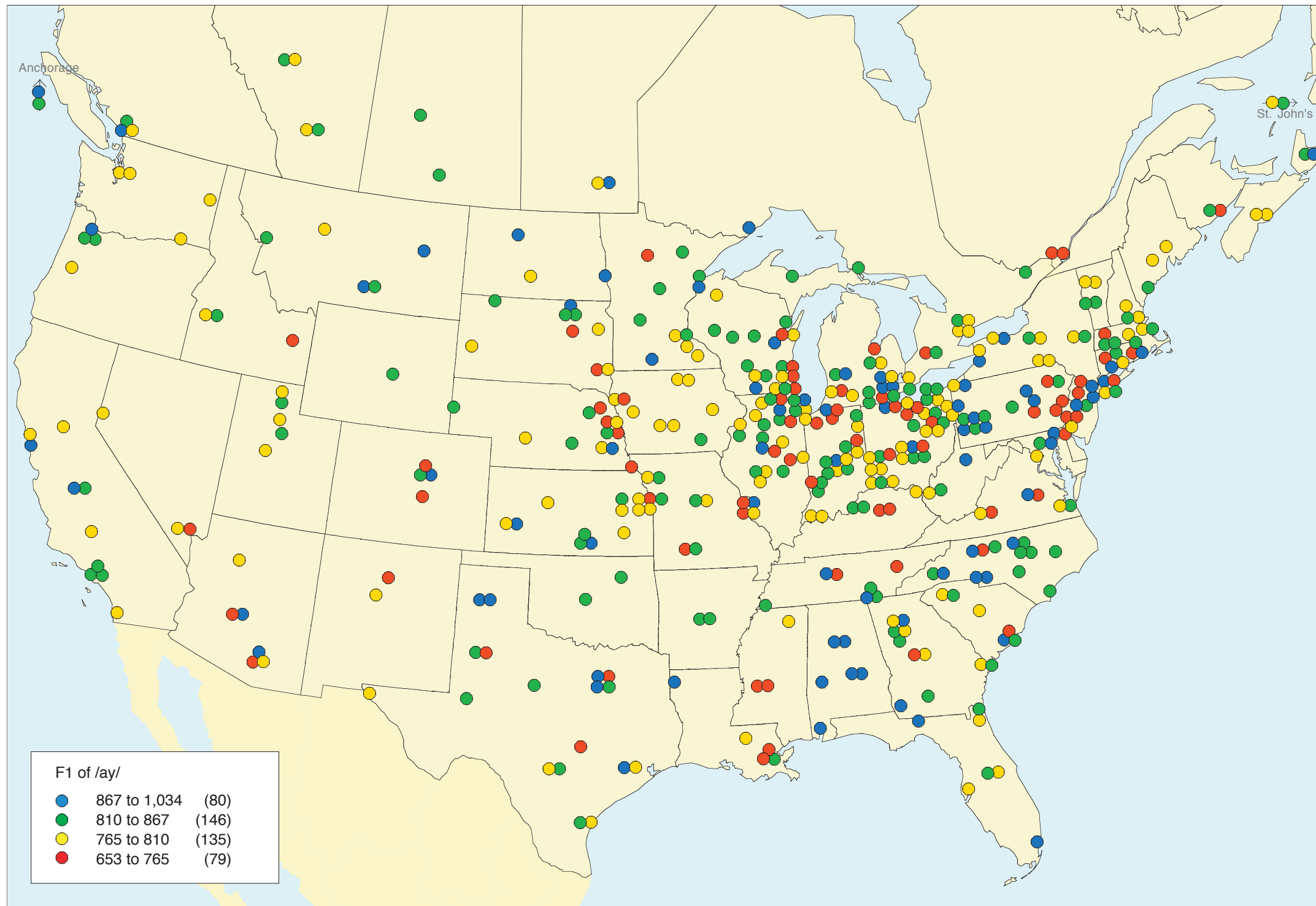


Map 10.18. The relative fronting and backing of /ey/ in *bait, made, may*, etc.

The uniform blue area in the South shows the backing of /ey/ that accompanies its lowering in Map 10.17, as /ey/ is lowered along the centralized, non-peripheral track. There is no corresponding predominance of red symbols in the Inland North, but Canada, along with much of the North Central and Pacific area, shows

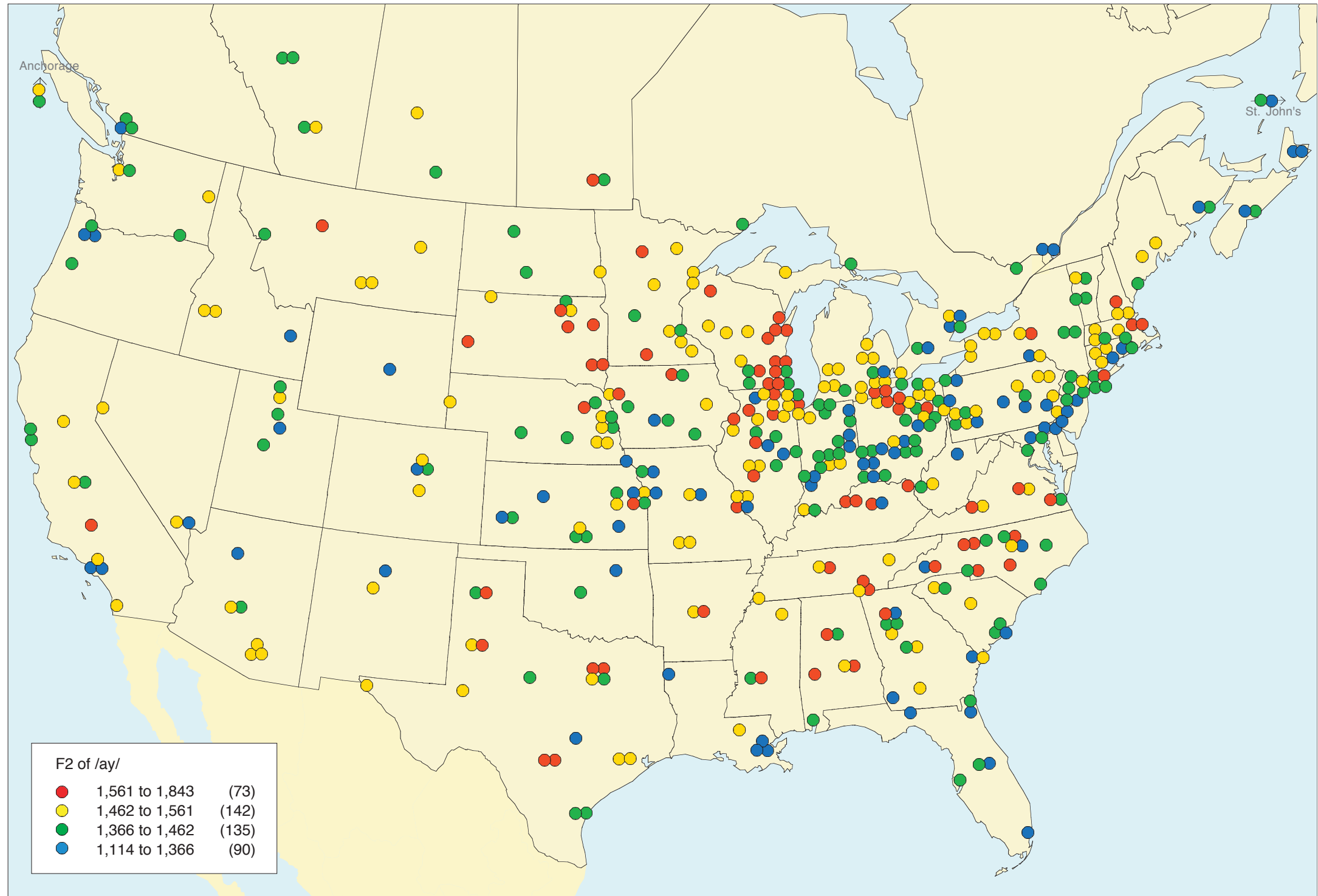
symbols that are almost uniformly red, showing a peripheral realization of /ey/. The Northern Cities Shift does not extend to areas that show such extreme positions for /ey/.





Map 10.19. The relative height of /ay/ in *wide*, *buy*, etc.

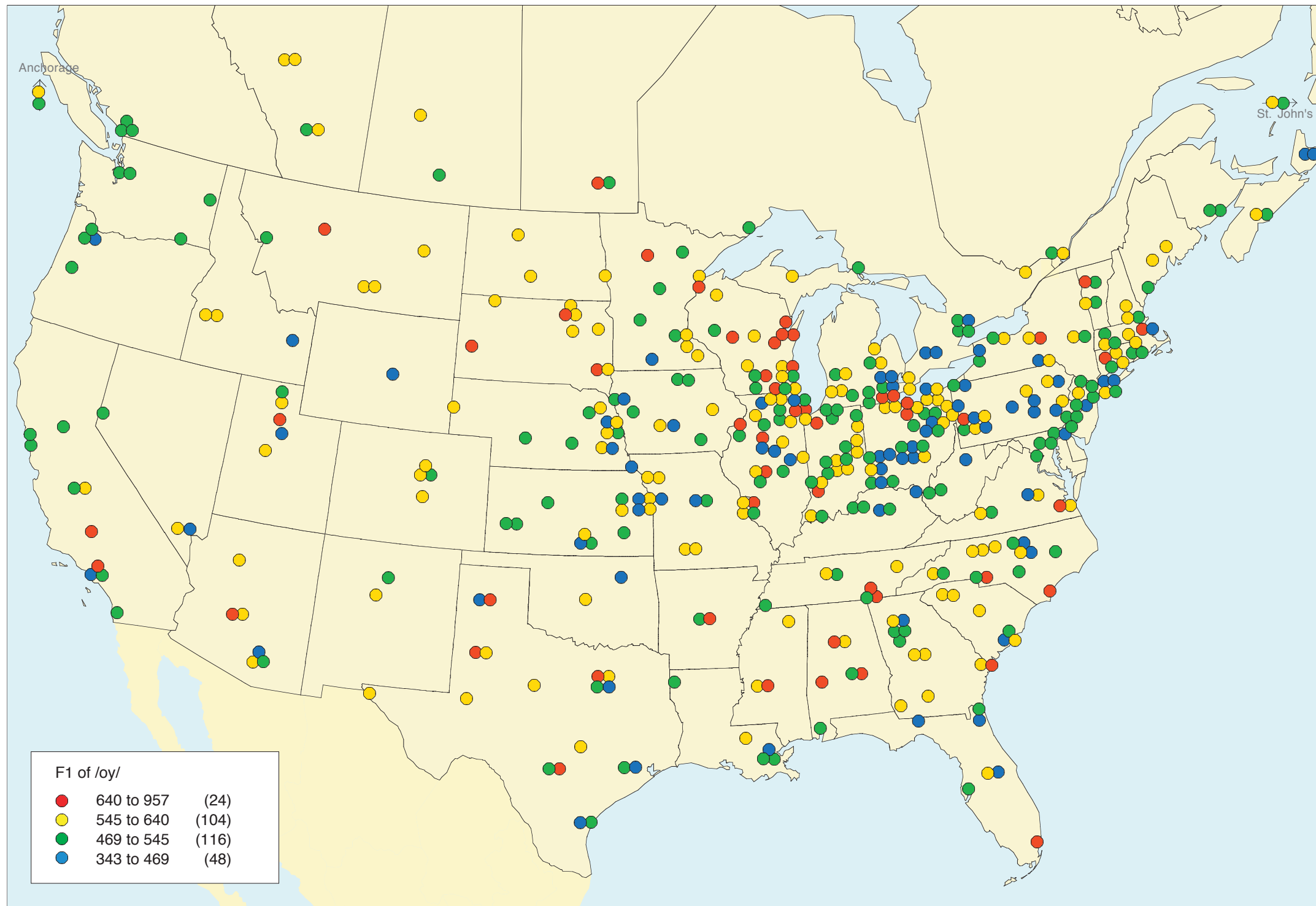
No heavy concentration of high or low realizations of /ay/ are found in this display. This map does not include /ay/ before voiceless consonants (Canadian raising), which is registered in Map 10.37. (See also Map 15.5, Figure 17.8.) A cluster of blue symbols appears throughout Alabama, indicating a low (and monophthongal) nucleus.



Map 10.20. The relative fronting and backing of /ay/ in *bite*, *wide*, *buy*, etc.

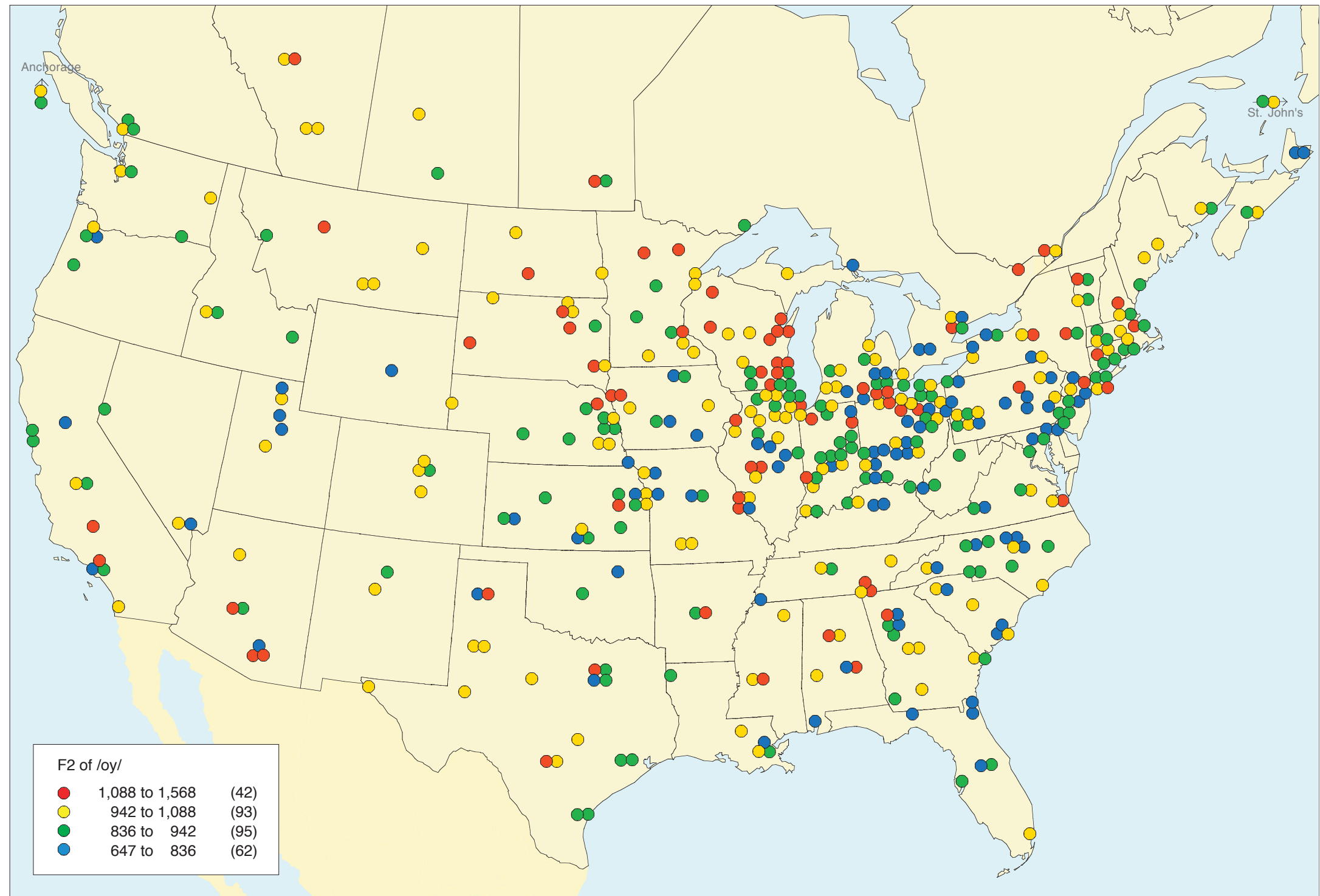
Deletion of the glide of /ay/ is accompanied by a slight fronting (Maps 11.3–4, 18.2–3), reflected here in the concentration of red symbols in the South. In the North, the nucleus of /ay/ moves forward in conjunction with the fronting of /o, ah/, reflected especially by a grouping of red circles in some Northern urban ar-

eas. Directly below the Great Lakes region, a broad belt of blue symbols indicates the opposite tendency in the Midland: relatively back nuclei of /ay/, which also appears in New Orleans, Montreal, and Atlantic Canada.



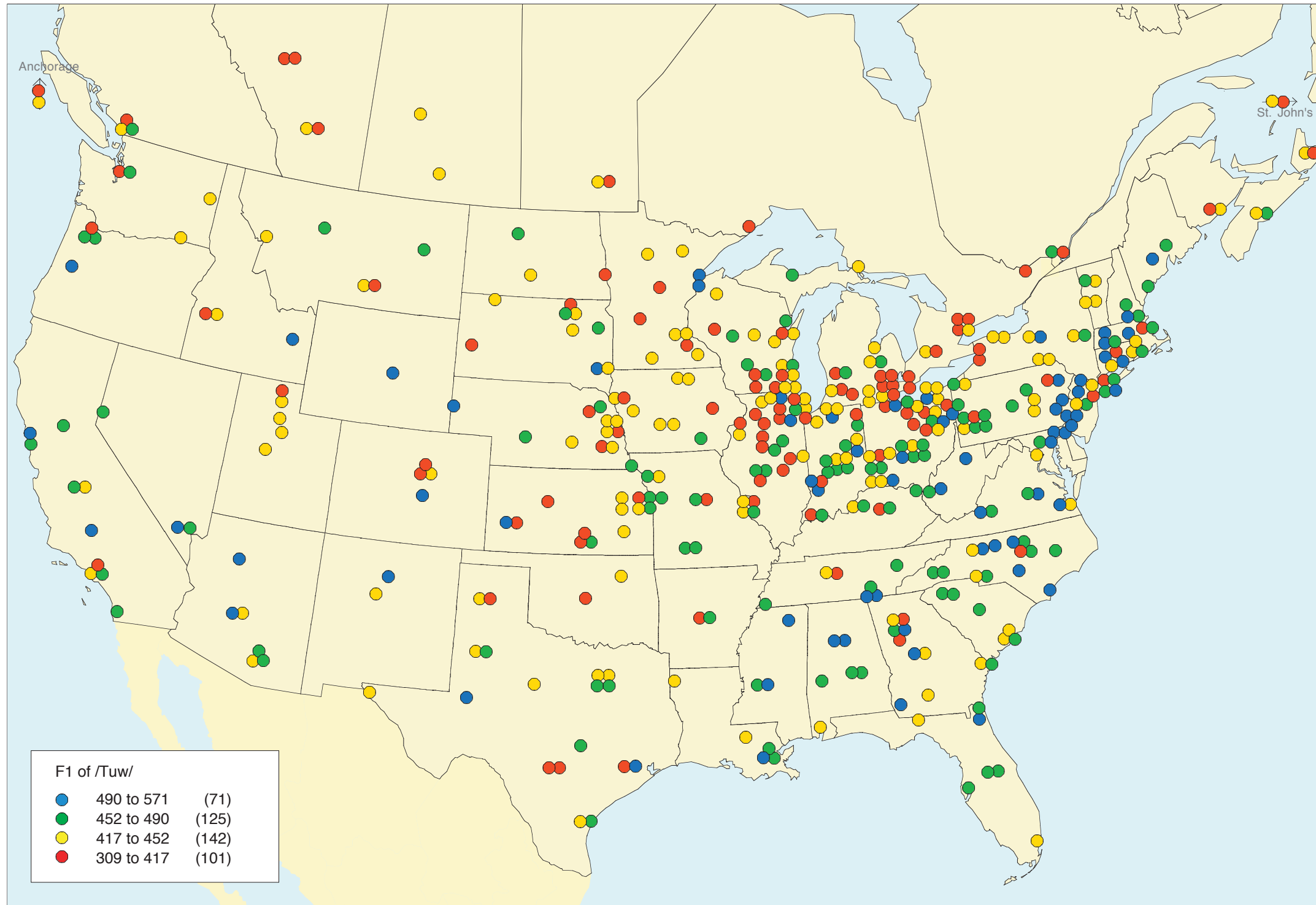
Map 10.21. The relative height of /oy/ in *voice*, *oil*, *boy*, etc.

There is no marked geographic concentration of the natural break groups apparent in Map 10.21. The phoneme /oy/ is relatively isolated and does not play a major part in the chain shifts, mergers or other sound changes traced in the chapters of the Atlas. The data are also relatively sparse: the total number of subjects who have reliable means for /oy/ is less than for any other phoneme.



Map 10.22. The relative fronting and backing of /oy/ in *voice*, *oil*, *boy*, etc.

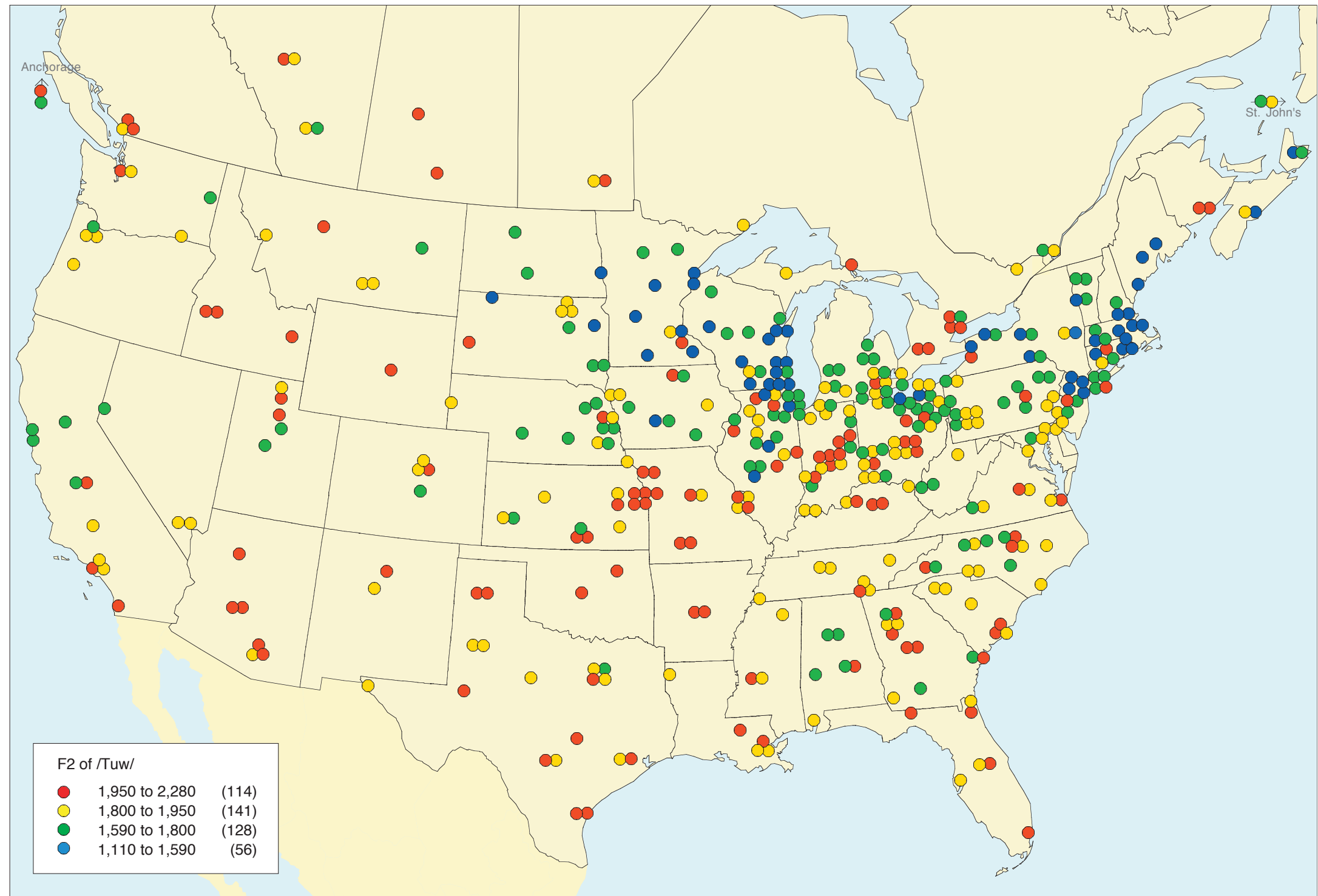
As in the previous map, /oy/ shows no striking geographic concentration of its relatively front and back realizations. The blue symbols, indicating relatively back realizations of this phoneme, are most strongly represented in the Midland area.



Map 10.23. The relative height of /Tuw/ in *soon*, *too*, *do*, etc.

The phoneme /uw/ is divided into two categories, /Tuw/ and /Kuw/, representing /uw/ after coronals and after non-coronals. The concentration of red symbols in the Northern area indicates that the nucleus–glide differentiation of /Tuw/ is minimal

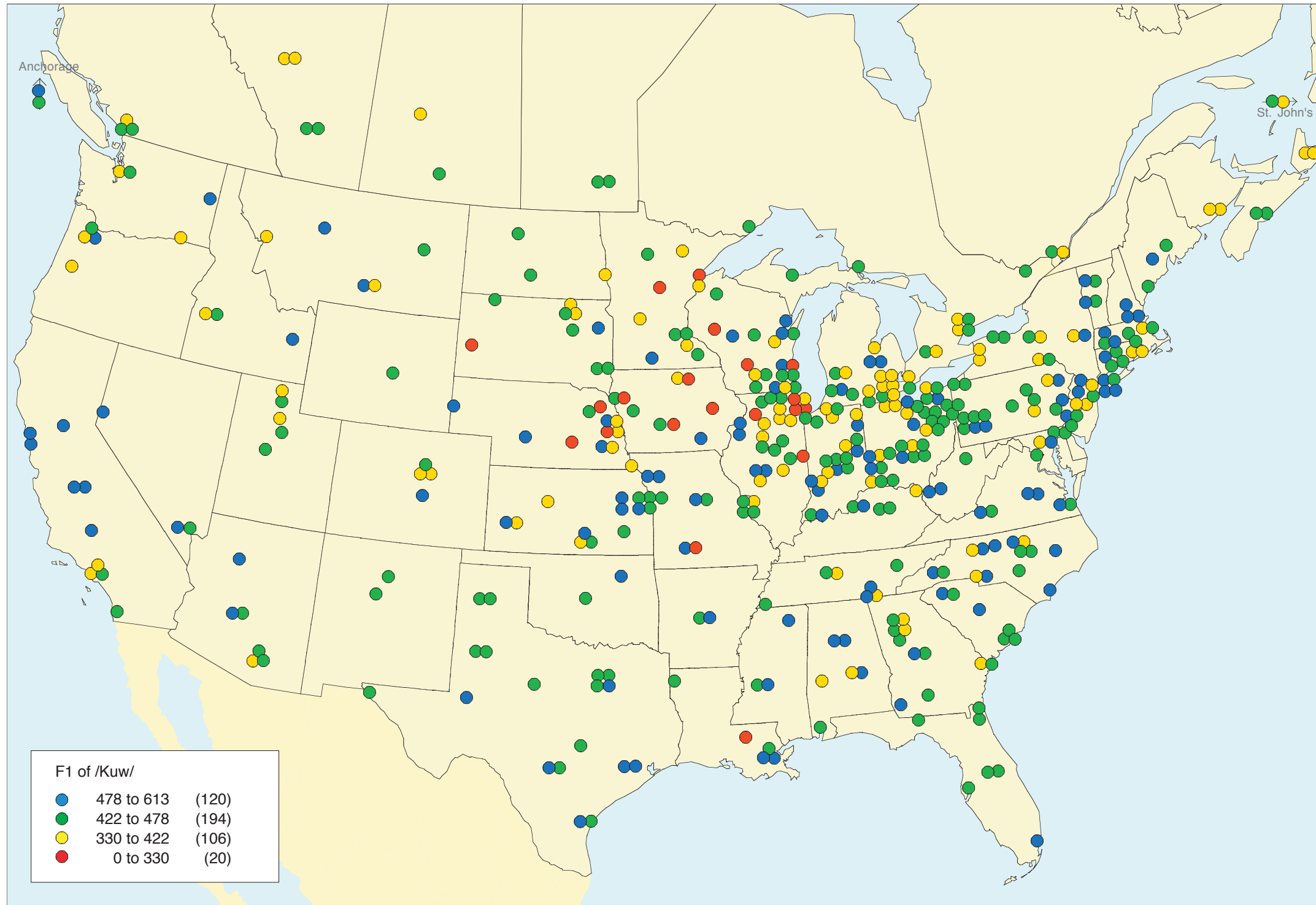
in the area of minimal fronting (see Map 10.24). The grouping of blue circles in the Mid-Atlantic region is striking and reflects the fact that /uw/ diphthongs have relatively low nuclei, with maximal distance between nucleus and glide.



Map 10.24. The relative fronting and backing of /Tuw/ in *soon, too, do, etc.*

The fronting of /Tuw/ is the most widespread tendency across all North American dialects. As Map 10.24 indicates, resistance to this fronting is concentrated in two specific areas: the North Central states of Wisconsin and Minnesota, and a north-eastern belt extending from western New York to northern New Jersey and north

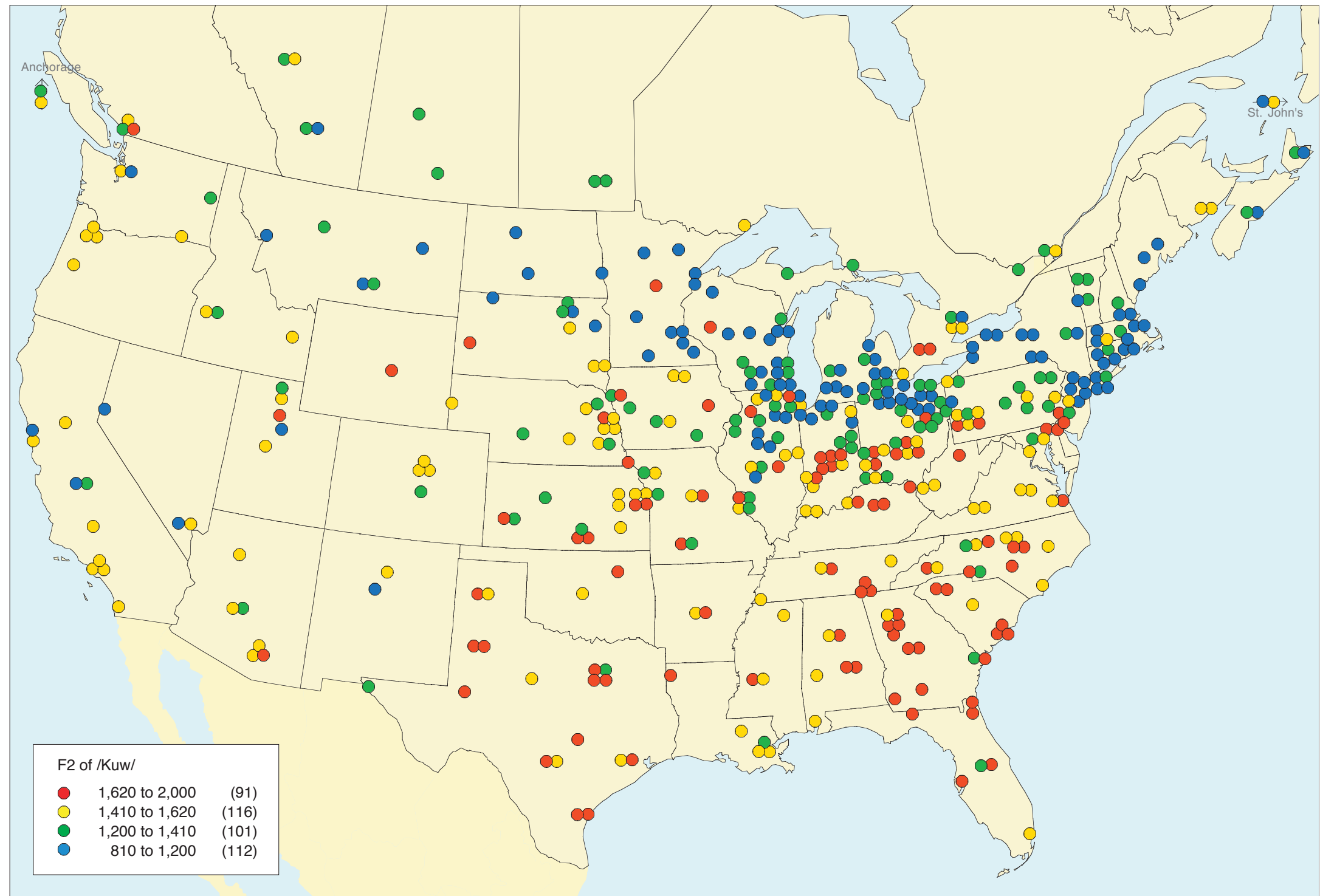
into New England. The rest of the North shows mostly green symbols. The red symbols indicating extreme fronting of /uw/ after coronals are found in the South and southern areas of the Midland, in the West and in Canada (Map 12.1).



Map 10.25. The relative height of /Kuw/ in *boot, move*, etc.

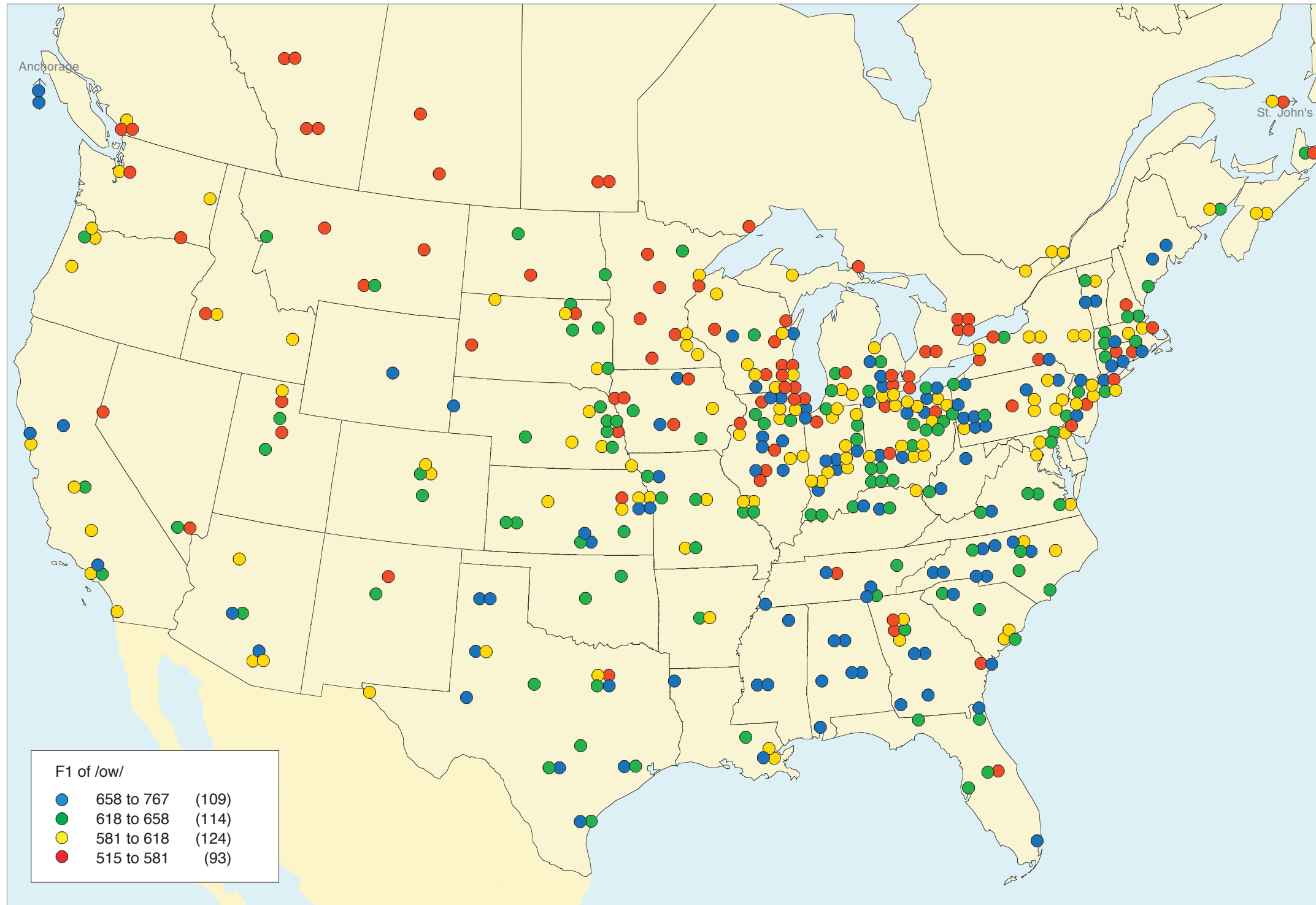
The /Kuw/ class designates /uw/ after non-coronal consonants. The degrees of fronting of these two classes are radically different, but there is no prominent role for the relative height of either in the sound changes reviewed in ANAE. There is a small collection of relatively high /Kuw/ in the North Central States (the red

symbols), which is associated with the tendency to use monophthongal /uw/ and /ow/ in that area. A concentration of blue symbols appears in California and the Southwest, indicating consistent lowering of this allophone. This does not appear for /Tuw/.



Map 10.26. The relative fronting and backing of /Kuw/ in *root*, *move*, etc.

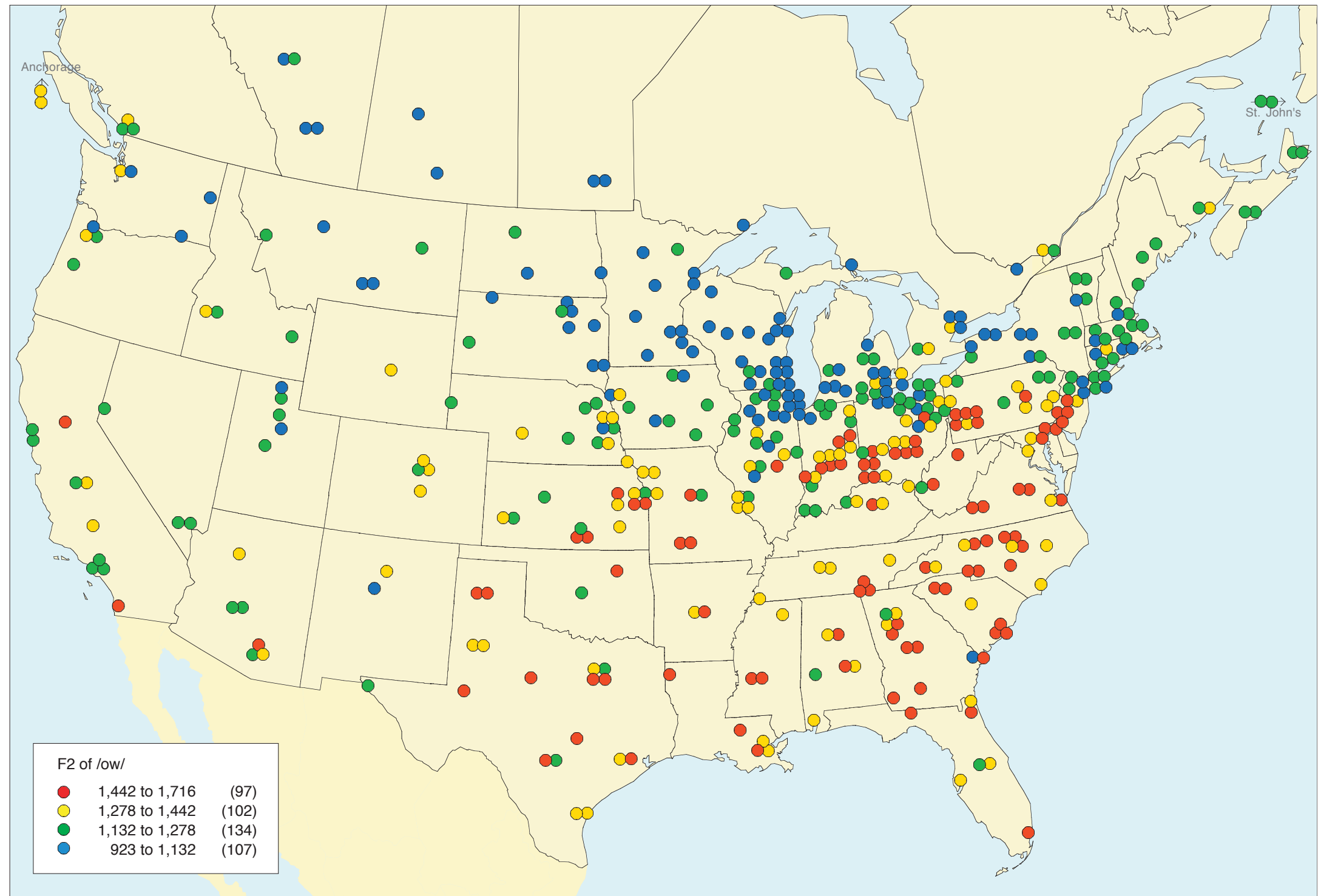
A very striking geographic pattern emerges in Map 10.26. The fronting of /uw/ after non-coronals is characteristic of the South and the Midland, as shown by the heavy concentration of red symbols throughout those areas (Map 12.2). Resistance to the fronting process is a feature of the North, extending quite far to the West and including all of New England and Nova Scotia.



Map 10.27. The relative height of /ow/ in *boat*, *road*, *go*, etc.

This map shows much clearer geographic separation than do the preceding maps for the relative heights of /Tuw/ and /Kuw/. The blue symbols indicating relatively low vowels are concentrated in the South and the Midland, while the red

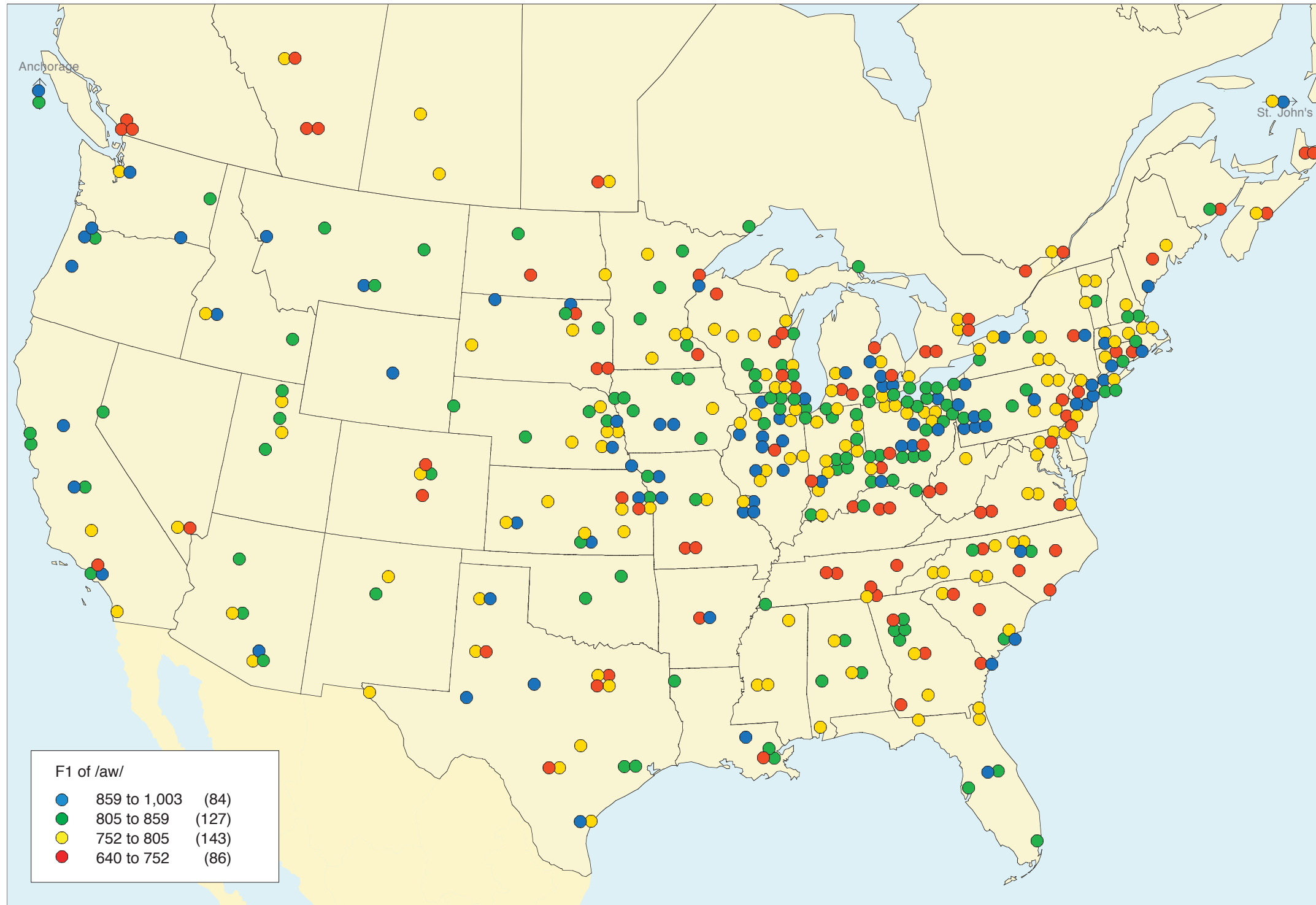
symbols indicating relatively high nuclei are found in the North and Canada. The red symbols in Atlanta are one of the many indications of strong Midland influence in that Southern city.



Map 10.28. The relative fronting and backing of /ow/ in *boat, road, go*, etc.

This map provides one of the most striking displays of geographic separation in this series. The fronting of /ow/ is characteristic of the South and the Midland, including the Mid-Atlantic states, but not New York City. Resistance to this front-

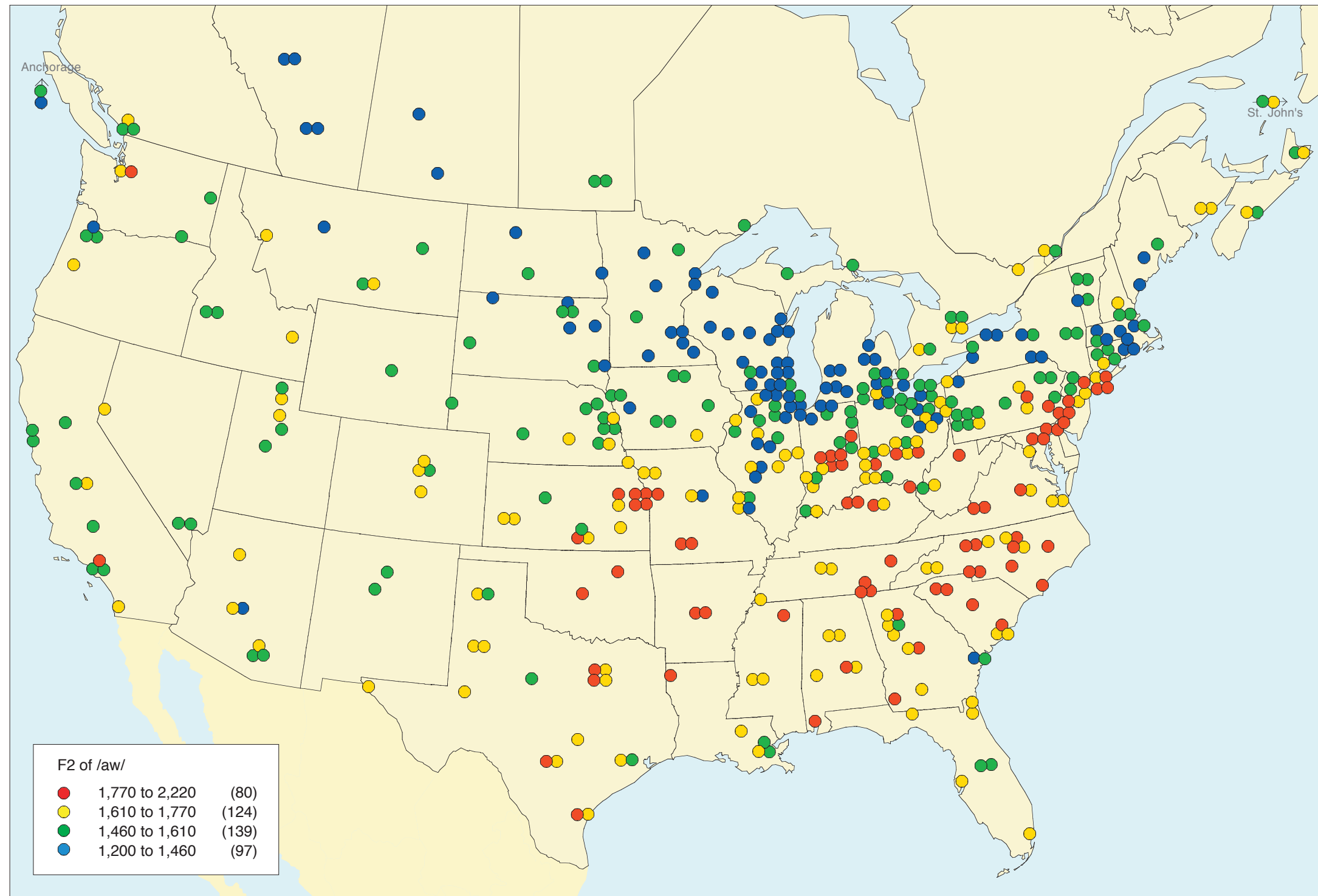
ing as shown by the blue symbols dominates the North and most of Canada. The West varies in this respect, with a gradual progression of blue to green to yellow symbols from north to south. See Chapter 12 and Map 12.3.



Map 10.29. The relative height of /aw/ in *out*, *loud*, *now*, etc.

This map differs from Map 10.19 in that the mean values do not include vowels before nasals, but they do include /aw/ before voiceless consonants. For the difference between the height of vowels before voiceless and voiced consonants, see Map 10.38. The concentration of red symbols in Canada is a reflection of Cana-

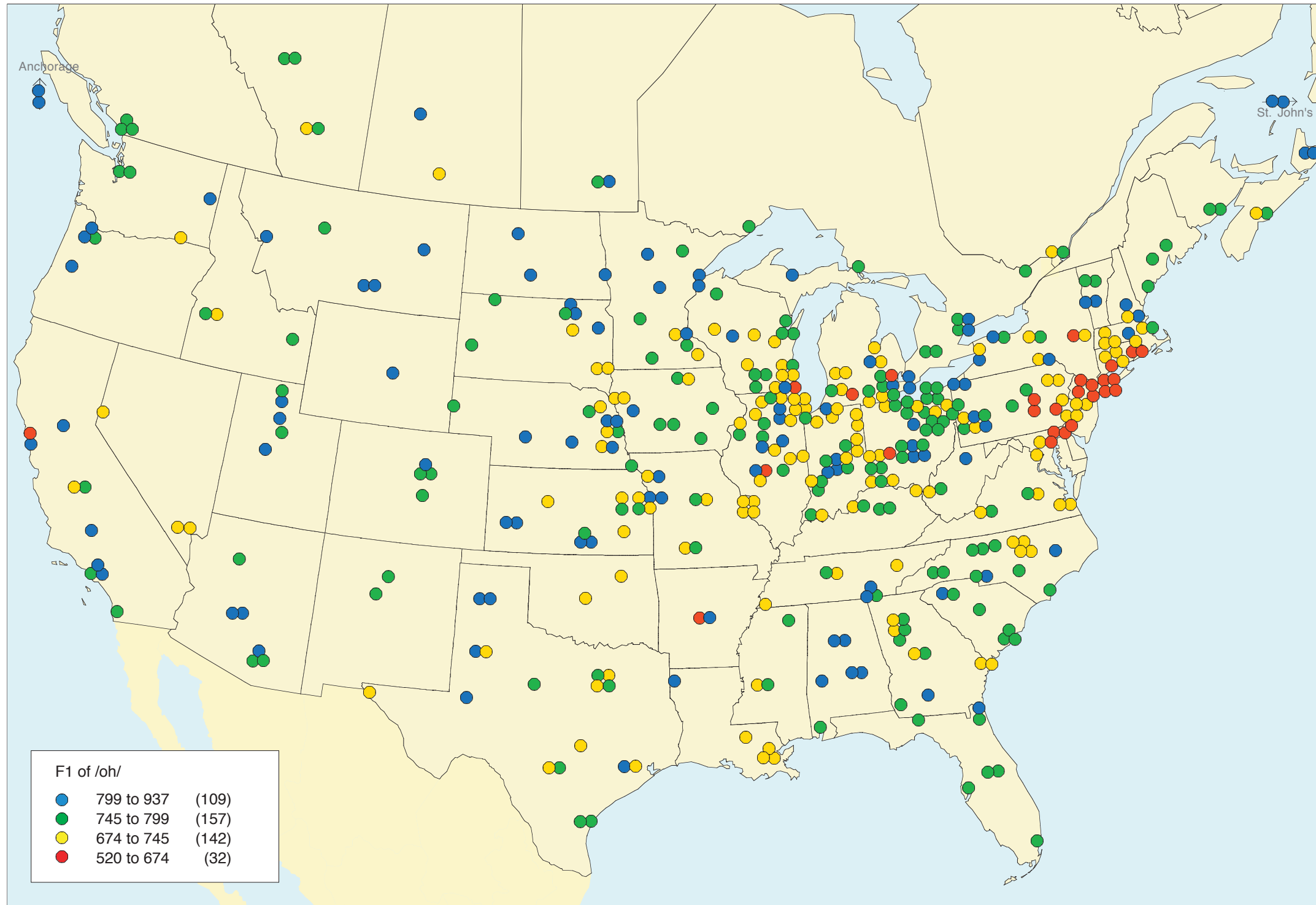
dian raising, in which the nucleus of /aw/ is centralized before voiceless consonants. Red circles are also found in Philadelphia and the Inland South, where they reflect not Canadian Raising but the raising of fronted /aw/ to [eo] (Map 12.4).



Map 10.30. The relative fronting and backing of /aw/ in *out*, *loud*, *now*, etc

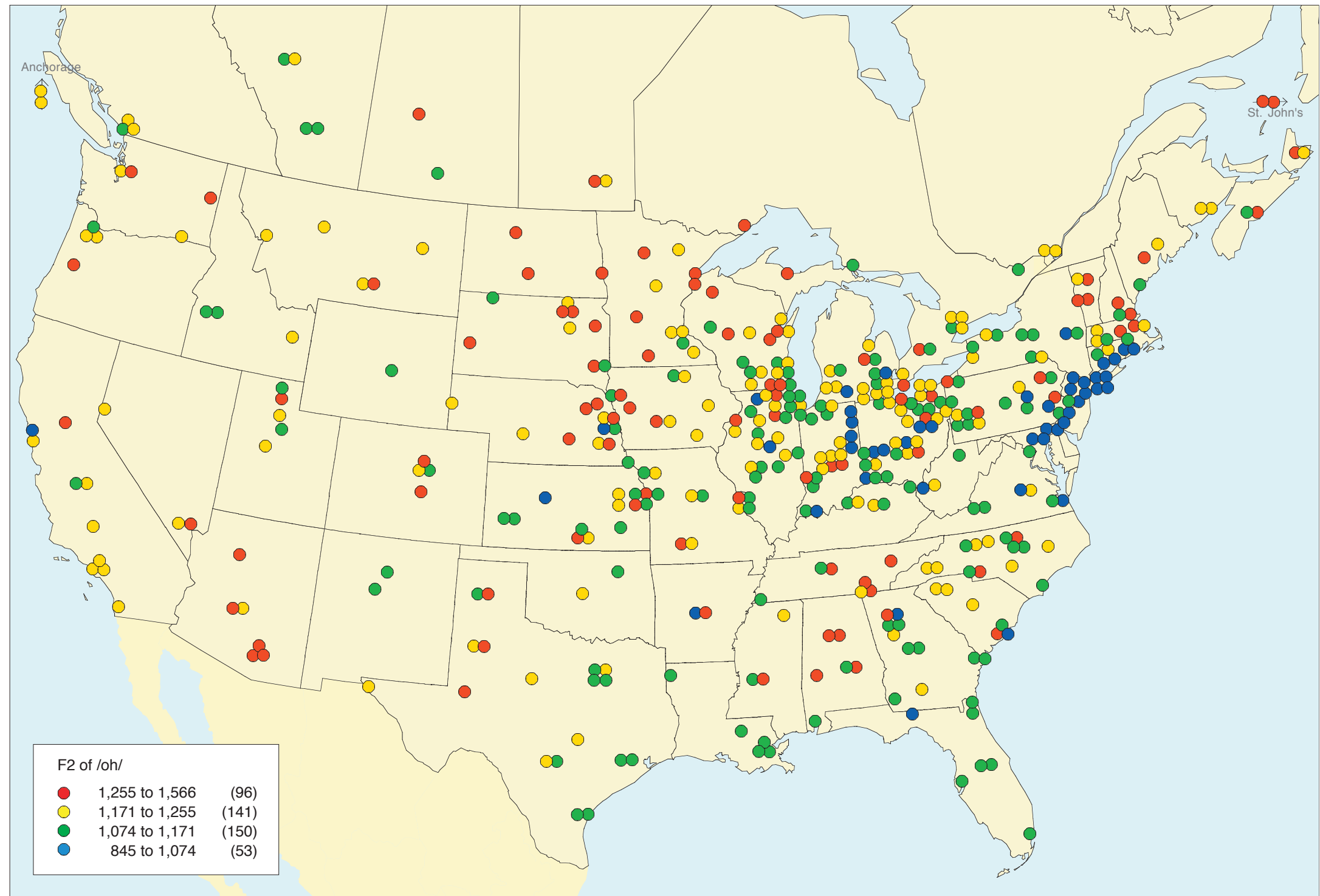
The geographic pattern seen here closely approximates the pattern of Map 10.28. There is a sharp North–Midland separation of back /aw/ vs. fronted /aw/ (Map 12.4). The Northern area of blue symbols extends westward to the North Central states and includes the prairie provinces of Canada. The region dominated by red circles, indicating strong fronting of the nucleus of /aw/, sharply delineates the

South and the southern half of the Midland area, extending eastward to Philadelphia and the Mid-Atlantic states. As with short-*a*, the mean values for /aw/ do not include vowels before nasals, which are considerably fronted (and often higher) than the main body of tokens.



Map 10.31. The relative height of /oh/ in *caught*, *cause*, *law*, etc.

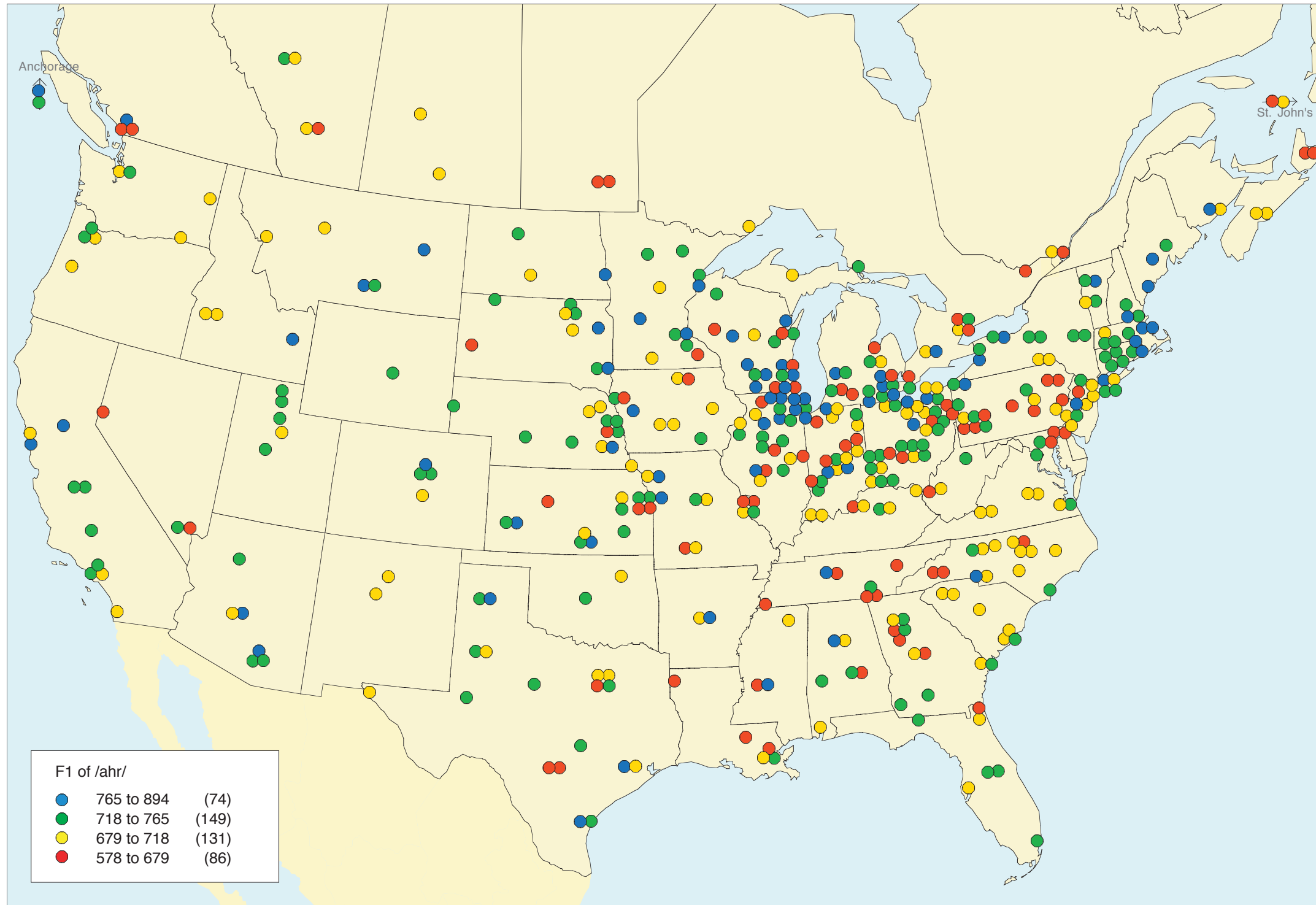
The relatively high position of /oh/ is a marked feature of a narrow band of communities on the eastern seaboard, as shown by the cluster of red circles extending from Rhode Island down to Maryland (Map 11.2, Chapter 17). For the rest of the continent, there is very little differentiation.



Map 10.32. The relative fronting and backing of /oh/ in *caught*, *cause*, *law*, etc.

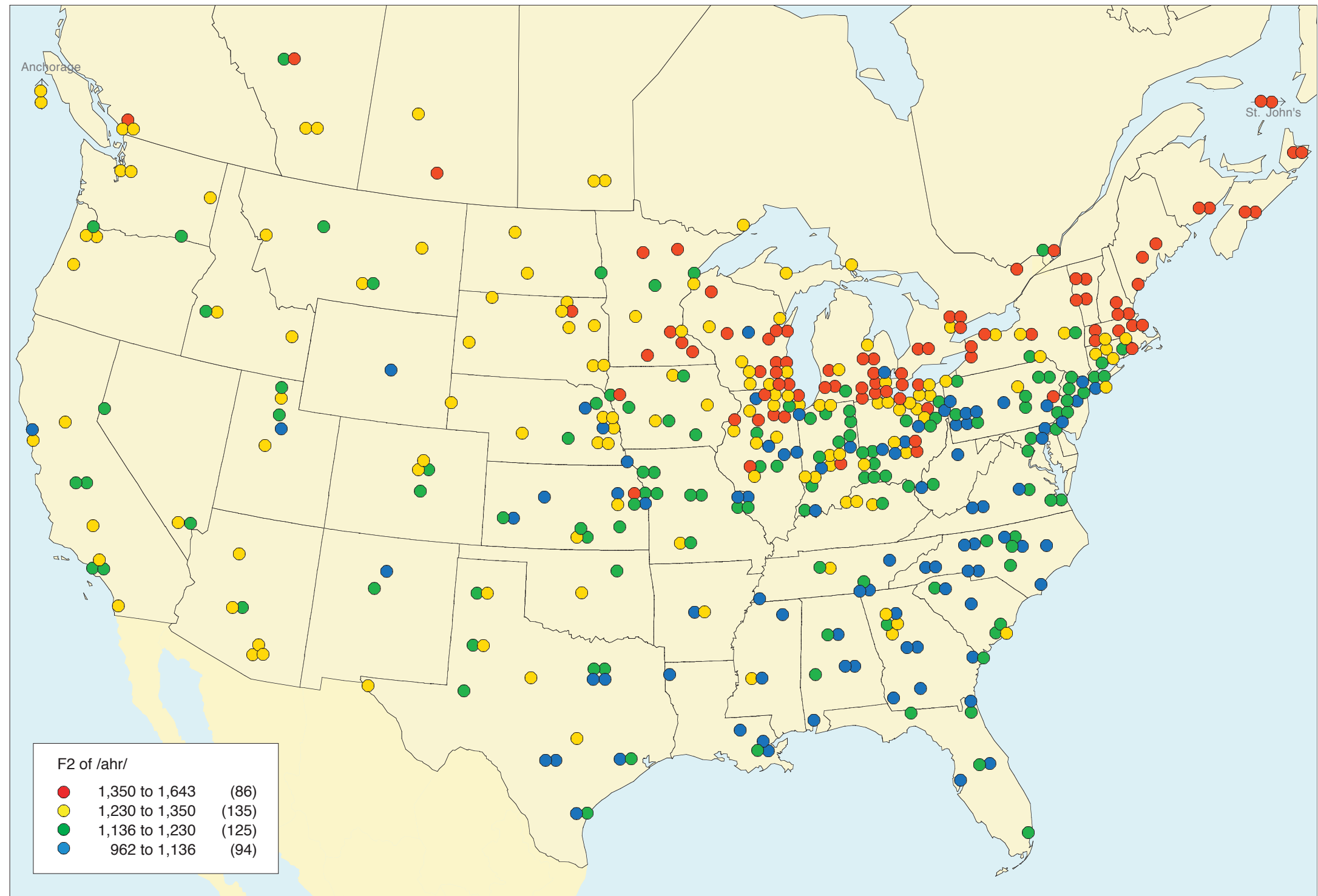
Blue symbols, indicating back forms of /oh/, follow the same belt of communities along the Eastern conurbation, even more densely than in Map 10.31. For the rest of the continent, there is no strong geographic grouping. In a few of the areas

where /o/ and /oh/ are merged, like Tucson, Arizona, and St. John's, Newfoundland, we find red symbols, indicating that the merger takes place at a relatively front position.



Map 10.33. The relative height of /ahr/ in *bar*, *card*, etc.

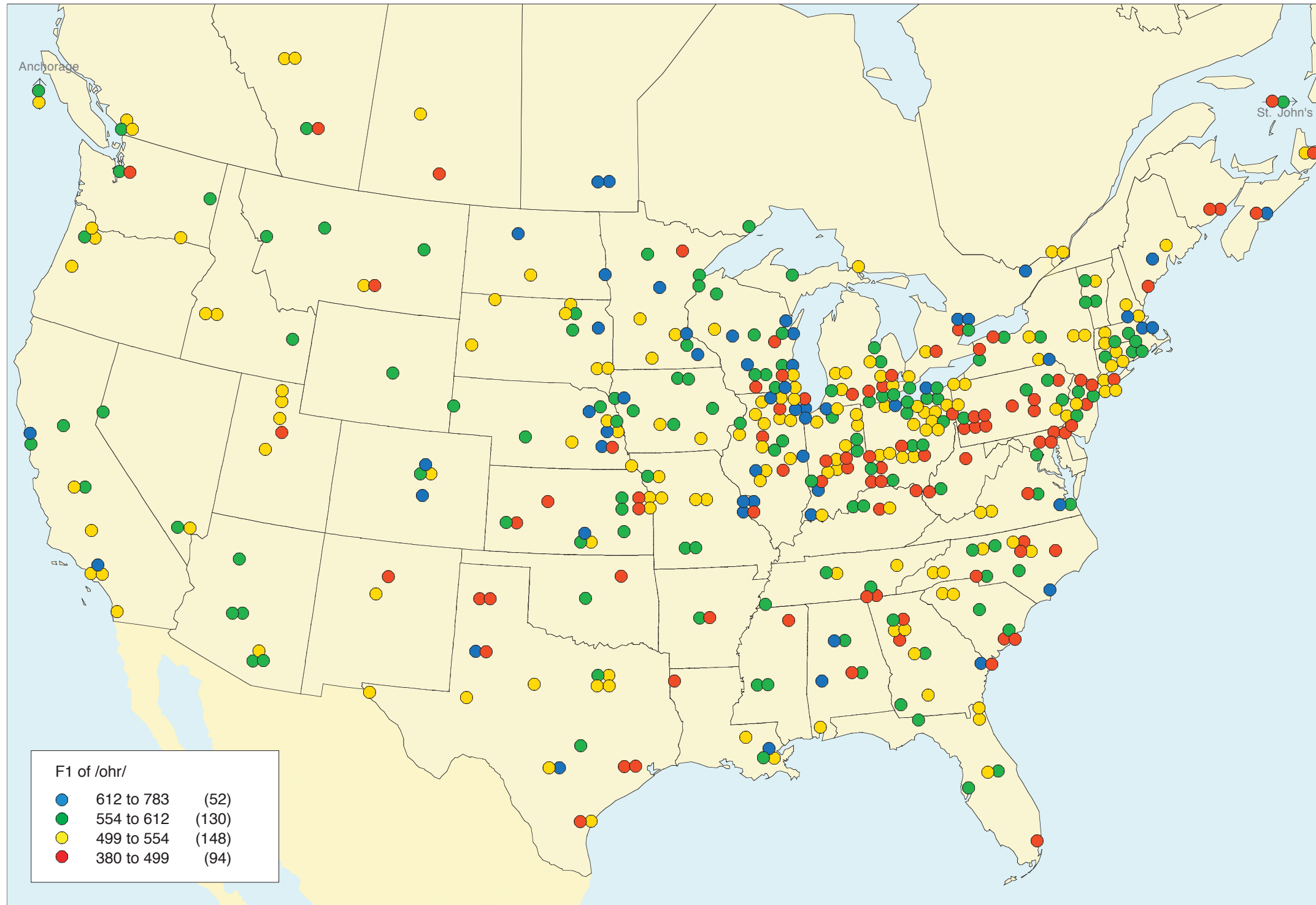
A certain degree of clustering is seen here for the blue circles, which indicates the relatively low position of this phoneme in two areas. In Eastern New England, /ahr/ is distinct from /o/ and merges with /ah/ as /r/ is vocalized; it is markedly lower in that area and in the Great Lakes region. However, the height of /ahr/ does not play as strong a role in dialect differentiation as does the fronting of this phoneme.



Map 10.34. The relative fronting and backing of /ahr/ in *bar*, *card*, etc.

The red circles which indicate the frontest group of /ahr/ values form a solid Northern area from Wisconsin to Maine and the Atlantic Provinces. The Eastern New England vocalization of /r/ in conjunction with the fronting of the nucleus of /ahr/ along with /ah/ is here not distinguished from the general Northern pat-

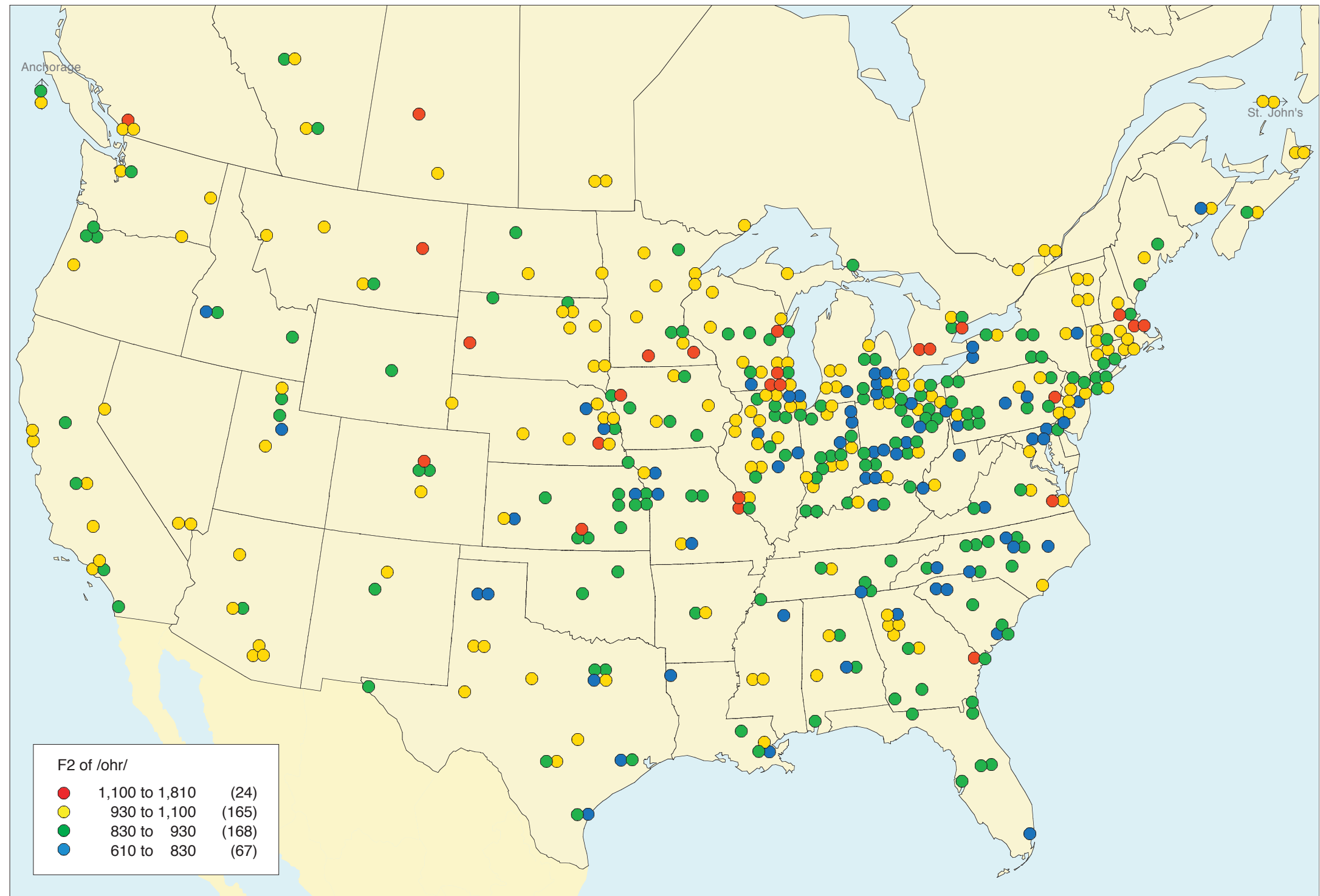
tern. In the Midland and South, by contrast, a heavy concentration of blue tokens indicates relatively retracted variants of this phoneme. The western half of the continent shows much less differentiation of /ahr/ on the front-back dimension.



Map 10.35. The relative height of /ɔhr/ in *short*, *cord*, *for*, etc.

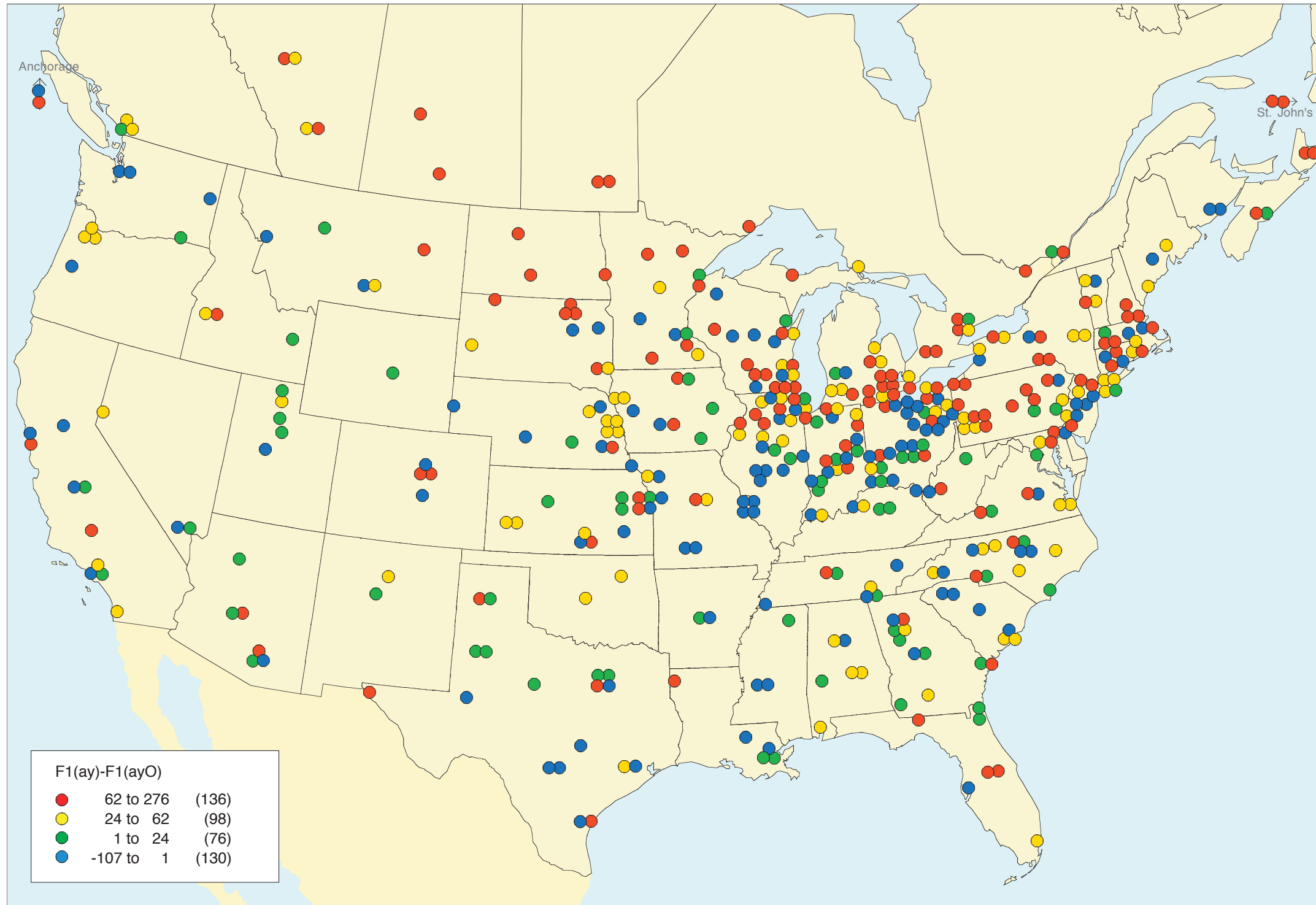
Relatively high forms of /ɔhr/ are found in the Mid-Atlantic states, as in Map 10.31, but the area extends westward to Pittsburgh and the southern portion of the Midland. The red circles indicating high vowels are also found throughout

the South and in the Atlantic Provinces of Canada. The word class of /ɔhr/ in *port*, *coarse*, *four* is generally merged with this class and follows the same pattern (see Chapter 2).



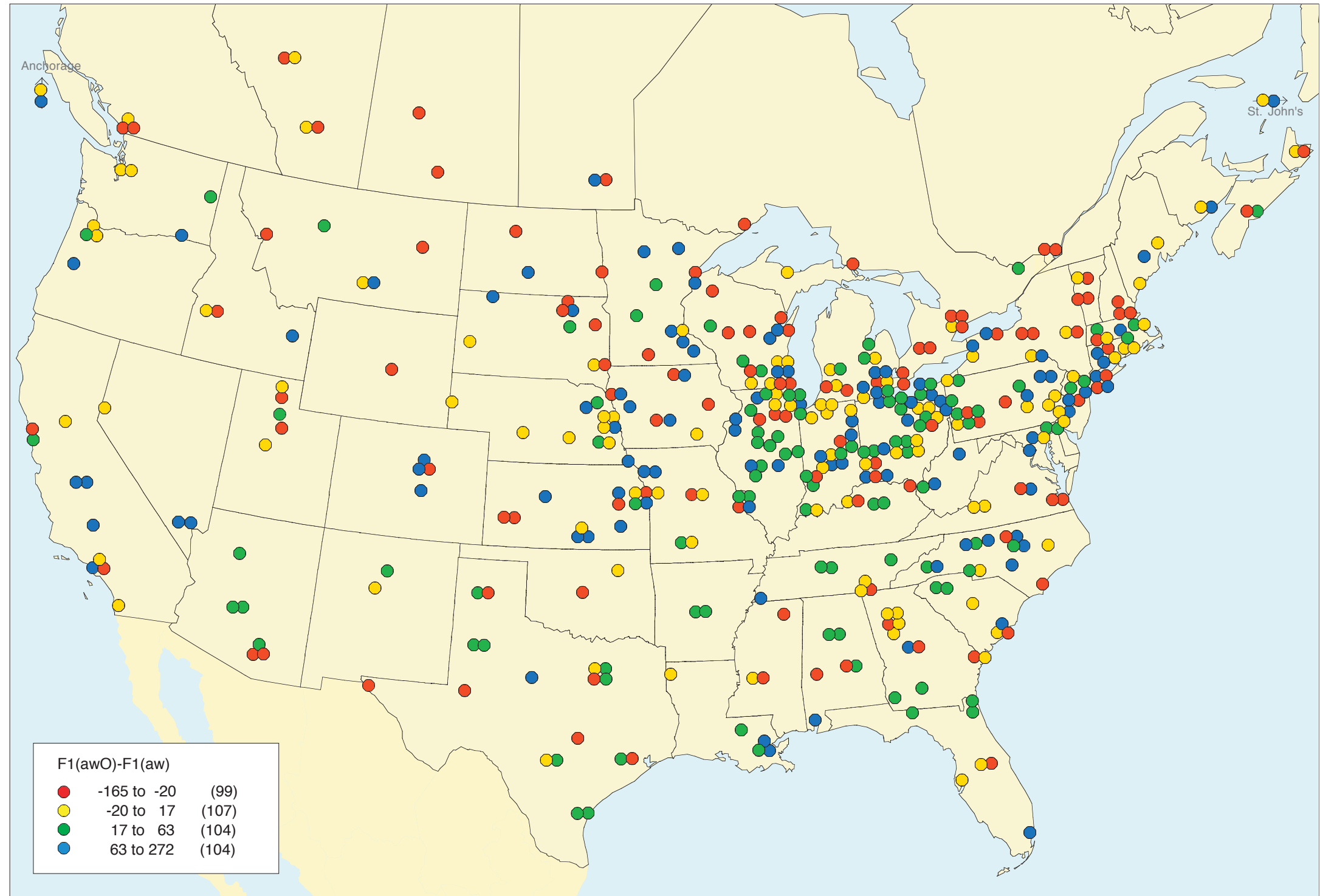
Map 10.36. The relative fronting and backing of /ohr/ in *short*, *cord*, *for*, etc.

There is only a light scattering of fronted /ohr/ indicated by red circles, as this vowel does not participate in the general fronting of the back upgliding vowels /uw, ow, aw/. The backer forms of /ohr/ are notably absent in Eastern New England, where the fronting of /ahr/ was observed in Map 10.34.



Map 10.37. Difference in height of /ay/ before voiced and voiceless consonants

Map 10.37 differs from previous maps in that it represents the difference between the F1 mean values before voiced and voiceless consonants. The red circles show the greatest difference, and the blue the smallest. Red circles are concentrated in areas where Canadian raising has traditionally been reported: Canada, Eastern New England, Philadelphia, and the North.



Map 10.38. Difference in height of /aw/ before voiced and voiceless consonants

Map 10.38 presents the differentiation of /aw/ before voiced and voiceless consonants. A smaller number of speakers are grouped in the highest category – 99 showing a range of 20 to 165 Hz. The most consistent pattern is shown in Canada (with some exceptions in Atlantic Canada), where Canadian Raising has long

been recognized. The red circles do not appear in the North with the consistency of Map 10.37, except for New York State. This map has less data than others, since some speakers did not provide tokens of both allophones.

Appendix A to Chapter 10

The following table gives the natural break ranges and numbers of speakers in each range for Maps 10.1-10.38.

		First formant			Second formant		
		From	Up To	N	From	Up to	N
/i/	red	412	487	82	2,073	2,366	51
	yellow	487	516	141	1,944	2,073	160
	green	516	543	118	1,857	1,944	139
	blue	543	603	99	1,410	1,857	90
/e/	red	503	624	98	1,922	2,227	91
	yellow	624	665	136	1,814	1,922	146
	green	665	703	137	1,708	1,814	133
/æ/	blue	703	795	69	1,356	1,708	70
	red	445	684	86	1,955	2,240	91
	yellow	684	749	130	1,843	1,955	130
/æN/	green	749	816	145	1,742	1,843	137
	blue	816	935	79	1,442	1,742	63
	red	348	575	103	2,269	2,628	112
/o/	yellow	575	647	138	2,117	2,269	152
	green	647	729	143	1,968	2,117	111
	blue	729	1,011	53	1,654	1,968	62
	red	630	779	82	1,443	1,716	79
/ʌ/	yellow	779	818	128	1,325	543	132
	green	818	860	130	1,230	516	151
	blue	860	1,052	100	1,042	487	78
	red	555	657	57	1,559	1,907	92
/u/	yellow	657	699	135	1,433	1,559	153
	green	699	744	158	1,337	1,433	136
	blue	744	864	89	1,095	1,337	58
	red	418	515	90	1,575	1,976	93
/iy/	yellow	515	556	150	1,404	1,575	138
	green	556	600	113	1,258	1,404	113
	blue	600	738	59	991	1,258	58
	red	305	371	62	2,447	2,807	125
/ey/	yellow	371	411	144	2,307	2,447	138
	green	411	458	150	2,157	2,307	115
	blue	459	626	82	1,819	2,157	60
	red	441	533	84	2,170	2,550	92
/ay/	yellow	533	573	137	2,030	2,170	146
	green	573	628	130	1,880	2,030	128
	blue	628	787	88	1,400	1,880	73
	red	653	765	79	1,451	1,843	73
/ay/	yellow	765	810	135	1,462	1,451	142
	green	810	867	146	1,366	1,462	135
	blue	867	1,034	80	1,114	1,366	90

		First formant			Second formant		
		From	Up To	N	From	Up to	N
/Kuw/	red	250	330	20	1,620	2,000	91
	yellow	330	422	106	1,410	1,620	116
	green	422	478	104	1,200	1,410	101
	blue	478	613	120	810	1,200	112
/ow/	red	515	581	93	1,442	1,716	97
	yellow	581	618	124	581	1,442	124
	green	618	638	114	1,132	581	134
/aw/	blue	638	767	109	923	1,132	107
	red	640	752	85	1,770	2,220	80
	yellow	752	805	143	1,610	1,770	124
/oh/	green	805	859	127	1,460	1,610	139
	blue	859	1,003	84	1,200	1,460	97
	red	50	674	32	1,255	1,566	96
	yellow	674	745	142	1,171	1,255	141
/ahr/	green	745	799	157	1,074	1,171	150
	blue	799	937	109	845	1,074	53
	red	578	679	86	1,350	1,643	86
	yellow	679	718	131	1,230	1,350	135
/ohr/	green	718	765	149	1,136	1,230	125
	blue	765	894	74	961	1,136	94
	red	380	499	94	1,100	1,810	24
	yellow	499	554	148	930	1,100	165
F1(ay)	green	554	612	130	830	930	168
	blue	612	783	52	610	830	67
	red	62	276	136			
	yellow	24	62	98			
-F1(ay0)	green	1	24	76			
	blue	-107	1	130			
	red	272	63	99			
	yellow	63	17	104			
F1(aw)	green	17	-20	107			
	blue	-20	-165	99			
	red						