Introduction

Football is built around comparative advantage. Players are selected to play specific positions based upon their ability to execute particular tasks. Teams select different players at a given position based on their ability to perform even more specific tasks and techniques within the team's system. For example, teams do not just select offensive linemen based on their ability to run block, they select them based on their skill level within a zone scheme or gap scheme. Defensive backs aren't just graded on an ability to play "coverage", but rather their ability to play man or zone or contribute in specific coverage types.

Grading players on a macro-level without accounting for what they are doing on a micro-level is like timing 100-meter dash times on different surfaces. Player selection is done by front offices who grade players at a very granular level, and consequently any attempts to evaluate players quantitatively should try to mimic that strategy. An inability to evaluate on a football-specific level results in inaccurate grading and allows quality players to fall through the cracks. The end result is an inefficient market that tries to average all aspects of a player's performance equally rather than assess what specific assignments a player is good at executing on the field.

For this project, we evaluate defensive players based upon their performance in specific techniques. To accomplish this, we create a coverage identification system which identifies both the overall coverage structure being played by the defense as well as the technique (man or zone) employed by any individual player. This provides a full picture of the coverage and allows us to grade players by specific assignments. From there, we create a metric called "enhanced separation" to evaluate how well defensive backs prevent separation by offensive players prior to the ball being thrown, as well as additional statistics to measure how well players close on the ball while it is in the air and play it at the moment of arrival. Finally, we assess the market for cornerbacks to determine if any inefficiencies exist.

Coverage Identification

Previous attempts to diagnose coverage using tracking data have relied upon grouping coverages together based upon the number of deep players that the defense uses, creating clusters of coverages named Cover 0, 1, 2, 3, 4, etc. This method of subsetting coverages is helpful for identifying which defensive players occupy deep parts of the field, but it does not indicate the types of assignments that underneath defenders may be responsible for. While Cover 3 is a zone coverage, teams will sometimes play man on number 1 (the widest offensive receiver) on one side while maintaining a Cover 3 structure across the rest of the field. An accurate name for this coverage might be "3 Lock" as most of the players in the coverage are playing Cover 3, but one corner is locked in man. Grading the man corner and the zone corner on the same scale would be neither fair nor accurate to both of those players.

This distinction is important because teams frequently play "hybrid" coverages consisting of both man and zone. For that reason, coaches traditionally refer to Cover 0, 1, 2, 3, 4, etc. as "shells" rather than "coverages". Shells can be determined almost entirely by where the cornerbacks and safeties are located right after the snap.

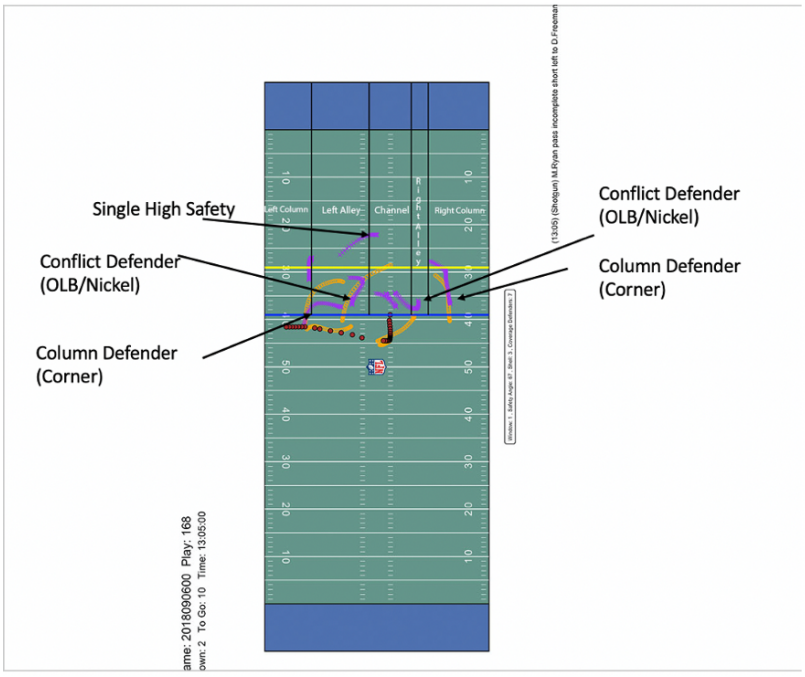
While defensive alignment and structure may seem somewhat nebulous at first glance, defenses must adhere to certain rules in order to properly function. All defenses must deny the middle of the field, maintain at least the same number of defenders as receiver threats in a given area, and maintain a structure that protects from the top down on any given play. It is how they adhere to these rules that allows us to identify coverage using our feature engineering algorithm.

One issue that arises in coverage identification is “positionless defense”--teams using players of different listed roster positions to fulfill roles outside what their position typically performs. There is no rule stopping a defensive coordinator from aligning a cornerback at safety, or a safety at middle linebacker. If a cornerback is lined up as a deep single-high safety, then our model must still be able to correctly identify him as such in order to accurately identify the coverage.

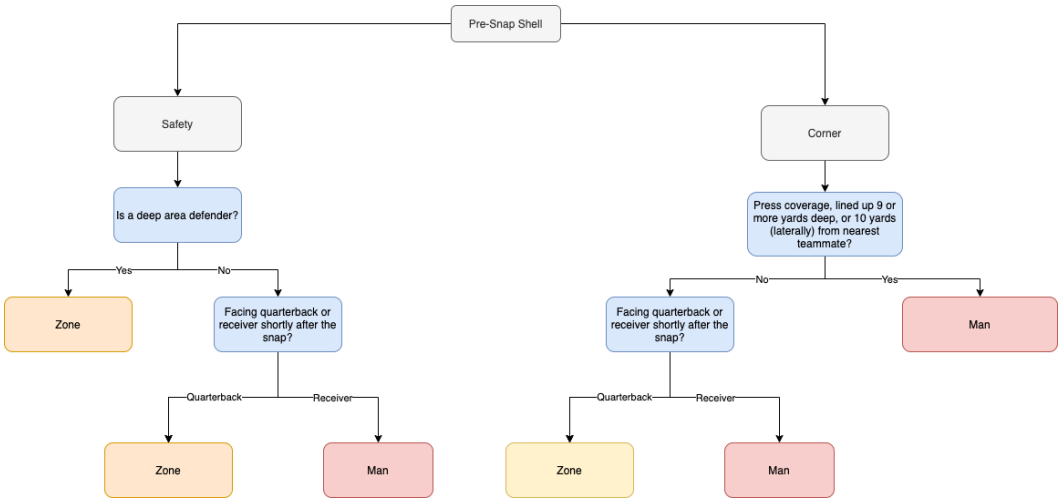
To determine a player’s role we created an identification system that identifies a player’s role based upon where he is on the field (in part inspired by the field area breakdown in Dub Maddox’s “What is Open?”), rather than his roster position. Defenders lined up in particular areas must adhere to certain rules in order for the defense to functionally work, so a player’s responsibility can be narrowed down by evaluating where he is in space. For example, the defender aligned over a detached #1 receiver will almost always be a coverage-priority player with little run responsibility. He is a key part of determining the shell, and although his role is generally performed by a cornerback, our model allows the flexibility for this player to be of any position. To figure out each player’s role, our system breaks the field down into five lateral areas which are spaced based upon the offensive formation (see the figure at the bottom of the page).

A player in the “column” is what we might traditionally think of as a cornerback, and a player in the “alley” is traditionally thought of as a “conflict” defender (OLB or nickel potentially playing with a run/pass conflict). The two deepest defensive backs anywhere between the columns are considered the safeties (a defensive coordinator would almost never ask a linebacker or DL to play a deep third or half, so we felt it was fair to only consider a player who is listed as a defensive back).

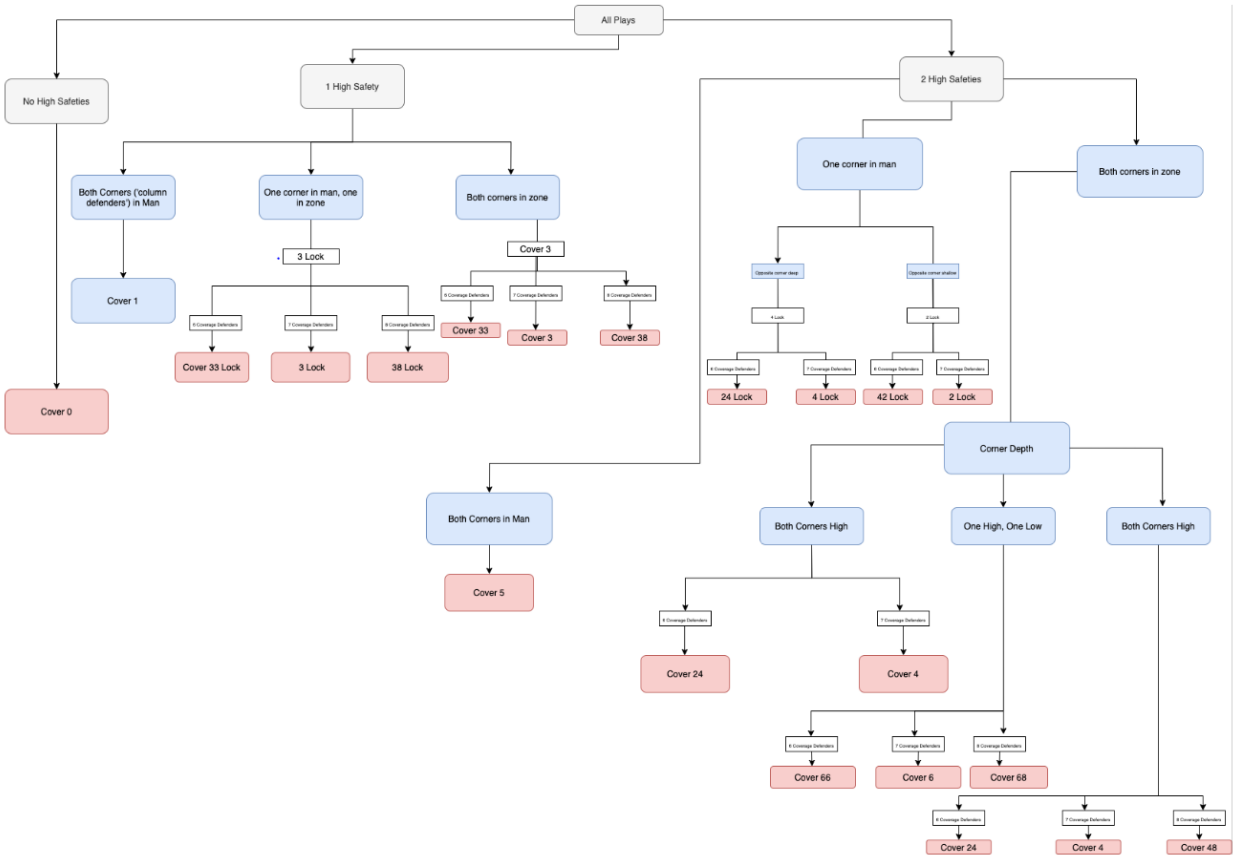
We use the player roles determined with this framework to figure out the deep structure of the field, focusing most of our attention on the safeties. We evaluate their depth and relative angle to determine if the shell is a one or two-high safety structure. From the shell, we use further feature engineering to determine if any individual player is in man coverage or zone coverage. Previous attempts have used machine learning methods to do this (like the Telemetry sports coverage labels provided in the competition prompt). We feel that this can be too much of a black box (additionally, as someone pointed out on the Kaggle page, the few visualized examples that Telemetry posted didn’t appear to be accurate). The tracking data gives us enough information to create a robust deterministic algorithm.



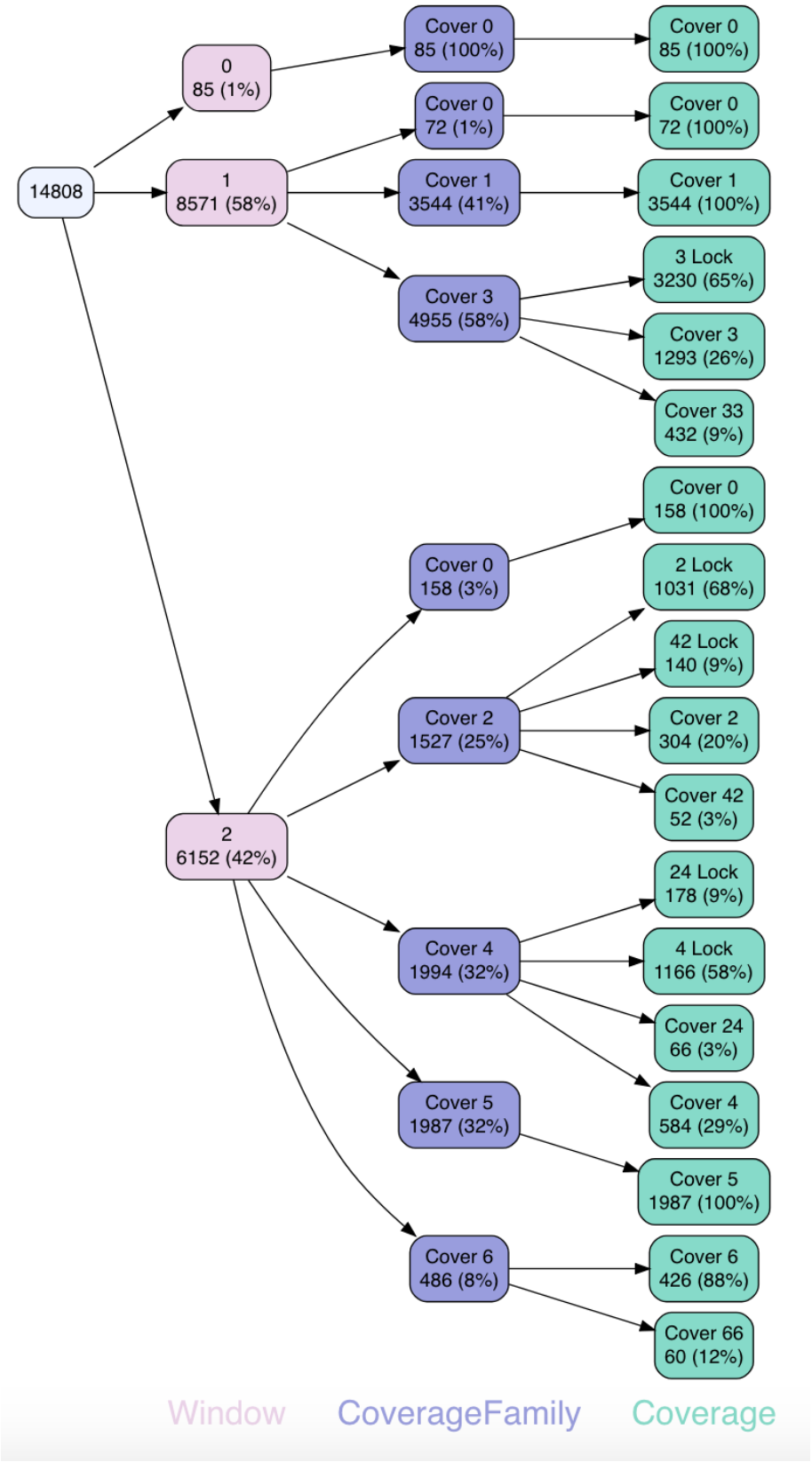
The features in the flowchart are highly suggestive of one type of coverage. For example, if the safeties are determined to be deep-half or deep-thirds players, they must be in zone. If corners are playing press coverage, they are more likely to be in man. Murkier cases are broken by orientation of the player as the play begins to develop. If the defender is looking at an offensive player who is not a QB, they are likely to be in man. If the defender is facing the quarterback, they are likely in zone.



Finally, we combine the shell ID with the man/zone coverage labels to fully identify the coverage. Below is a flow chart for the full identifications as well as a tree with a breakdown of how many plays had each coverage and coverage family.



% Breakdown of Coverages



Effective Separation Analysis

To evaluate players on their performance within a given coverage or technique, we analyze player separation, which is intuitively critical for defending the pass. Our simplest measure of separation determines the Euclidean distance between the targeted receiver and nearest defender at the time of the throw and relates it to pass completion. However, separation depends on other factors: speed, acceleration, and direction. We use these factors to create a metric known as “enhanced separation.” This is created using the fitted values from a regression where time-of-throw differences in distance, speed, acceleration, and direction between the target receiver and closest defender are employed to project eventual separation when the pass arrives. All four measures of trajectory difference are very statistically significant in this model.

$$PassArriveSeparation=b+b1(ThrowSeparation)+b2(DeltaSpeed)+b3(DeltaAccelerati on)+b4(DeltaDirection)+e$$PassArriveSeparation=b+b1(ThrowSeparation)+b2(DeltaSpeed)+b3(DeltaAcceleration)+b4(DeltaDirection)+e

In linear probability regression models, enhanced separation is consistently an accurate predictor of completion percentage. Moreover, as measured by the Bayesian Information Criterion (BIC), enhanced separation also performs better than the constituent regressors used to generate it. Thus, it follows that enhanced separation efficiently extracts the meaningful information contained in its components. The top defenders by enhanced separation, and hence the best at putting themselves in a good position prior to the throw are included below:

Enhanced Separation					
Defender Name	Completions Allowed	Play Count	**Average Enhanced Primnary Separation**	Targets	PrimaryDefPosition
William Jackson	35	650	**2.207986**	75	CB
Holton Hill	5	401	**2.352502**	22	DB
Trevor Williams	20	316	**2.358539**	27	CB
Stephon Gilmore	43	509	**2.371994**	93	CB
Casey Hayward	29	316	**2.390692**	57	CB
Darius Slay	38	401	**2.430053**	83	CB
Steven Nelson	49	692	**2.456752**	107	CB
J.C. Jackson	24	566	**2.495224**	47	DB
Greg Mabin	9	461	**2.536854**	17	CB
Eric Rowe	8	509	**2.551299**	15	CB

Several players were skilled at closing gaps predicted by enhanced separation to be large. The best at closing the gap are:

Average Enhanced Gap Closed					
Defender Name	Completions Allowed	Play Count	**Average Enhanced Separation Gap Closed**	Targets	PrimaryDefPosition
Reshad Jones	14	102	1.88059609	20	SS
Lamarcus Joyner	10	461	1.78512539	20	FS
Xavier Woods	15	566	1.61144622	20	FS
Johnathan Joseph	45	573	1.51972079	82	CB
Josh Jones	13	169	1.51631943	17	SS
Charvarius Ward	14	176	1.44738453	20	DB
Tony Jefferson	14	81	1.39019617	26	SS
Sean Davis	10	252	1.38689134	16	SS
Ronnie Harrison	12	573	1.37208195	18	DB
Devin McCourty	31	509	1.35239287	45	FS

In certain regressions, we incorporated player-specific indicators. These coefficients estimate the ability of a defender to defend the pass after accounting for situation and separation, measuring ability to interfere with the pass for a certain separation. The best defenders at knocking the ball away as it arrives (best ball skills) are:

Player	Ball Skills Coefficient
Brian Orakpo	-0.67
Xavier Woods	-0.66
Devon Kennard	-0.58
Vic Beasley	-0.58
A.J. Klein	-0.57
Ramik Wilson	-0.48
Josh Harvey-Clemons	-0.46
Clayton Geathers	-0.45
Eric Reid	-0.45
Tre Boston	-0.43
Marquel Lee	-0.42
Demario Davis	-0.41

Player Measurables and Market Inefficiencies

One of the most valued traits for defensive backs is "player length," the combination of a player's height and arm length. Front offices believe length to be important when evaluating defensive backs, believing that greater height and arm length leads to improved ability to jam at the line and play the ball in the air. The Seattle Seahawks, a successful team defensively the past decade, have notably employed this strategy.

While the advantages of selecting "longer" cornerbacks are clear, the disadvantages are not as obvious. It is traditionally held that athletic ability and agility decrease with increasing height. Taller players with ganglier frames generally cannot move as smoothly or efficiently as shorter, more compact players. Corners with both size and agility may be in short supply, setting the stage for a potential market inefficiency. We find that teams pay taller and longer corners more and select them earlier in the draft (see Figure 1 in Appendix). However, the relationship between separation, height, and arm length is not straightforward.

We find that separation and height have a statistically significant, negative relationship: taller players allow less separation. Conversely, we find that arm length and separation have no significant relationship. Even when controlling for arm length and height simultaneously, we find that taller corners prevent separation more effectively, with longer armed corners actually doing worse at preventing separation (though the relationship is not statistically significant). This suggests that shorter corners generally cannot compensate for a lack of height by having longer arms.

We also performed an analysis to determine if a similar relationship exists with ability to knock the ball away as it arrives and length (see Figure 3 of Appendix), but found no relationship between either height or arm length and ability to knock the ball away (it is important to note that this does not account for differences in height between the defender and receiver, but is instead is aggregated across all players and plays). No relationship exists between height or arm length and the ability to close on the ball in the air either.

To look deeper into corner valuation, we subset into young (≤ 4 years in NFL, likely on rookie contract) and older (≥ 5 years) corners. For younger corners, both height and arm length correspond to better draft position, indicating GMs value both those traits when selecting players in the draft (we analyze draft position rather than salary since few players receive new contracts in their first few seasons). However, when evaluating older corners (presumably on a later contract), only height has a significant (positive) relationship with compensation, with no evidence of a significant relationship between arm length and salary.

Why is this? We hypothesize that when projecting if a defensive back's abilities will translate from the college to NFL game, front offices are overvaluing the role of arm length, hoping that shorter players can overcome their lack of height if they have longer arms. When these corners reach free agency and can be evaluated on their NFL performance, GMs spend more on corners who are tall, without significantly valuing arm length. This is because, as noted before, enhanced separation is affected by height but not arm length. In short, the market for corners is inefficient in the draft but corrects itself in free agency and contract extensions.

We recommend front offices prioritize cornerback height in the draft, and value the length of his arms to a lesser degree, as height is more consequential in limiting opponent separation. While arm length may be valuable in other contexts (shedding blocks, tackling), it appears to be differentially valued in the draft than in veteran contracts, suggesting a possible actionable market inefficiency.

Appendix:

Figure 1: Valuation and Combine Measurable Regressions

All Corners				
Salary Cap Hit Y, Height Primary X				
term	estimate	std.error	statistic	p.value
(Intercept)	-46143376	35647386	-1.29	0.199
Height	693808**	335726	2.07	0.042
BMI	575122	478948	1.2	0.233
BenchPress	156909	125635	1.25	0.215
FortyYardDash	-7408349	5412050	-1.37	0.175
BroadJump	121115	82542	1.47	0.146

Salary Cap Hit Y, Arm Length Primary X				
term	estimate	std.error	statistic	p.value
(Intercept)	-16022430	40864631	-0.392	0.696
ArmLength	1173362*	614114	1.91	0.0611
BMI	232780	623577	0.373	0.71
BenchPress	201630	163645	1.23	0.223
FortyYardDash	-8155038	6714620	-1.21	0.23
BroadJump	77723	104192	0.746	0.459

Young Corners				
Draft Pick # Y, Height Primary X				
term	estimate	std.error	statistic	p.value
(Intercept)	3186	1237	2.57	0.0133
Height	-27.2**	11.3	-2.41	0.0201
BMI	-33.6**	15.4	-2.19	0.0337
FortyYardDash	18.8	171	0.11	0.913
Vertical	-8.42*	4.66	-1.81	0.0776

Draft Pick # Y, Arm Length Primary X				
term	estimate	std.error	statistic	p.value
(Intercept)	1674	1154	1.45	0.156
ArmLength	-40.1**	16.5	-2.44	0.0204
BMI	-8.63	16.6	-0.521	0.606
FortyYardDash	35.3	196	0.18	0.858
Vertical	-5.98	5.45	-1.1	0.28

Old Corners				
Salary Cap Hit Y, Arm Length Primary X				
term	estimate	std.error	statistic	p.value
(Intercept)	-55177468	74617556	-0.739	0.465
ArmLength	519796	912039	0.57	0.573
BMI	617217	1002171	0.616	0.543
FortyYardDash	2885874	11859644	0.243	0.809
Vertical	430882	446845	0.964	0.343

Salary Cap Hit Y, Height Primary X				
term	estimate	std.error	statistic	p.value
(Intercept)	-140207265*	81772802	-1.71	0.0958
Height	1301183**	636061	2.05	0.0488
BMI	1514680	983695	1.54	0.133
FortyYardDash	1446862	10652219	0.136	0.893
Vertical	175329	402345	0.436	0.666

Figure 2: Separation and Measurable Regressions

Corners Only				
Enhanced Separation Y, Height Primary X				
term	estimate	std.error	statistic	p.value
(Intercept)	3.54	6.34	0.558	0.579
Height	-0.119*	0.0599	-1.98	0.0511
BMI	-0.0516	0.0878	-0.588	0.558
BenchPress	0.0184	0.0241	0.764	0.447
FortyYardDash	2.1	0.974	2.16	0.0342
BroadJump	0.00123	0.016	0.0769	0.939

Enhanced Separation Y, Arm Length Primary X				
term	estimate	std.error	statistic	p.value
(Intercept)	-2.69	5.4	-0.497	0.621
ArmLength	-0.0736	0.0806	-0.913	0.364
BMI	0.00702	0.0837	0.0839	0.933
BenchPress	0.0163	0.0246	0.662	0.51
FortyYardDash	1.84	0.99	1.86	0.0671
BroadJump	-0.00135	0.0165	-0.0817	0.935

Enhanced Separation Y, Including Both Height and Arm Length as Controls				
term	estimate	std.error	statistic	p.value
(Intercept)	4.38	6.59	0.665	0.508
Height	-0.145*	0.0801	-1.81	0.0742
ArmLength	0.0527	0.106	0.499	0.619
BMI	-0.0624	0.0909	-0.687	0.494
BenchPress	0.0191	0.0243	0.788	0.434
FortyYardDash	2.06**	0.983	2.1	0.0396
BroadJump	-0.0000198	0.0162	-0.00122	0.999

Figure 3: Close the Gap Regressions

Corners Only				
Avg Enhanced Distance Closed Y, Height Primary X				
term	estimate	std.error	statistic	p.value
(Intercept)	3.35	4.8	0.699	0.487
Height	0.00935	0.0453	0.206	0.837
BMI	-0.0472	0.0665	-0.71	0.48
BenchPress	-0.00534	0.0182	-0.293	0.771
FortyYardDash	-0.842	0.737	-1.14	0.257
BroadJump	0.00942	0.0121	0.779	0.439

Avg Enhanced Distance Closed Y, Arm Length Primary X				
term	estimate	std.error	statistic	p.value
(Intercept)	3.71	4.01	0.926	0.358
ArmLength	0.0152	0.0598	0.254	0.801
BMI	-0.0512	0.062	-0.825	0.412
BenchPress	-0.00512	0.0182	-0.281	0.78
FortyYardDash	-0.847	0.734	-1.15	0.253
BroadJump	0.00915	0.0122	0.749	0.456

Enhanced Distance Closed Y, Both Height and Arm Length as Cont				
term	estimate	std.error	statistic	p.value
(Intercept)	3.55	5	0.711	0.48
Height	0.00314	0.0607	0.0517	0.959
ArmLength	0.0124	0.0801	0.155	0.877
BMI	-0.0497	0.0689	-0.721	0.473
BenchPress	-0.00518	0.0184	-0.281	0.779
FortyYardDash	-0.852	0.745	-1.14	0.257
BroadJump	0.00912	0.0123	0.741	0.461

Figure 4: Ball Skills Regressions

Corners Only				
Ball Skills Y, Height Primary X				
term	estimate	std.error	statistic	p.value
(Intercept)	-0.697	1.03	-0.674	0.502
Height	-0.00435	0.00984	-0.442	0.66
BMI	-0.00351	0.0142	-0.247	0.806
BenchPress	0.00122	0.0039	0.312	0.756
FortyYardDash	0.188	0.157	1.2	0.236
BroadJump	0.00107	0.00258	0.413	0.681

Ball Skills Y, Arm Length Primary X				
term	estimate	std.error	statistic	p.value
(Intercept)	-0.821	0.855	-0.96	0.341
ArmLength	-0.00968	0.0128	-0.755	0.453
BMI	-0.00187	0.0133	-0.141	0.888
BenchPress	0.0011	0.00389	0.283	0.778
FortyYardDash	0.198	0.157	1.27	0.209
BroadJump	0.00132	0.0026	0.507	0.614

Ball Skills Y, Both Height and Arm Length as Controls				
term	estimate	std.error	statistic	p.value
(Intercept)	-0.871	1.08	-0.809	0.421
Height	0.00103	0.0132	0.0778	0.938
ArmLength	-0.0106	0.0173	-0.612	0.543
BMI	-0.00139	0.0147	-0.0944	0.925
BenchPress	0.00108	0.00392	0.275	0.784
FortyYardDash	0.197	0.159	1.24	0.219
BroadJump	0.00131	0.00263	0.499	0.619

Field Identification System

Areas of the Field

- The Column is the area on each side of the field that extends from the sideline to just inside of the #1 receiver. This area only contains the “column” player, who is almost always a cornerback. Regardless of the player’s roster position, this player is a key piece of the shell.

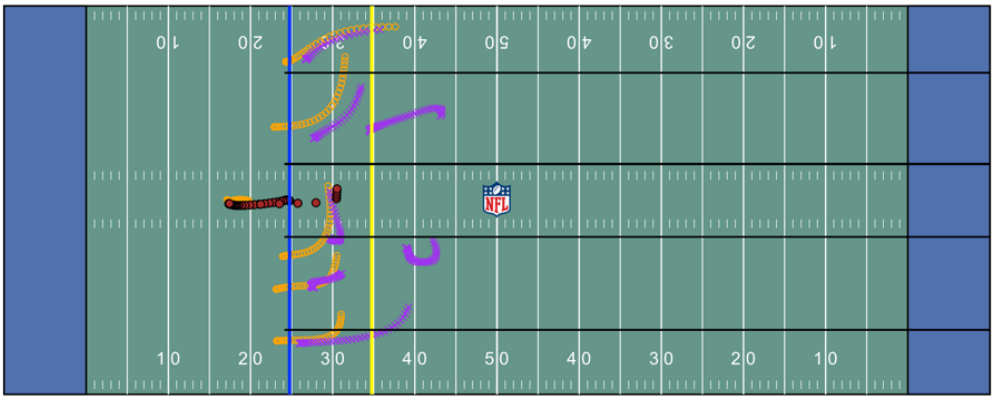
- The Alley is the area on each side of the field that extends from the column line on the outside to either the midpoint between the #2 and #3 receiver (if it is a 3-receiver side), or to just outside the tackle box (where a 3-point stance tight end would line up). In few cases where the #1 is in as tight as or even inside a typical tight end’s alignment, the alley does not exist.

- The Channel is the area between the alleys. The tackle box is located in the channel.

- The Chute is the combined area of the alleys and the channel.

Sample play diagram with field areas drawn:

Week: 2 Game: 2018091300 Play: 60
Quarter: 1 Down: 1 To Go: 10 Time: 15:00:00



(15:00) (Shotgun) J.Flacco pass incomplete short middle to M.Crabtree (H.Nickerson).

More visualizations and coverage ID labels are on the last two pages of this document.

Player Types:

Column Defenders are coverage-priority players who align over #1 on each side of the ball. These players are typically listed as cornerbacks on rosters. The depth of the column defender at the snap helps determine the shell. We define them as players in “the column” (see Figure). They are crucial to identifying the overall coverage structure.

Conflict Defenders are players who align close to the line of scrimmage in the space between #1 and the box. Consequently, these players often play with a run/pass conflict (though they do not always play with one if they are detached or in man coverage). These players are typically listed as outside linebackers, cornerbacks (nickel corners), and strong safeties. We define them as players in “the alley” (see Figure). They are key defenders in reading a defense, but the shell and overall coverage can be determined without understanding their responsibilities.

Adjacent Defenders are players in the box. They are typically inside linebackers or in some cases strong/box safeties. These players are typically responsible for interior run gaps and play with a run/pass conflict inside the box. They align in the channel, and are not key to identifying the shell.

Safeties are players toward the center of the field and furthest away from the ball. They are the most important defenders for determining the shell, as they determine whether the middle of the field is open or closed (1-high vs. 2-high structure). Safeties are the two deepest defensive players in the chute (or in the column in certain situations) at the snap. Safeties do not need to be listed on rosters as safeties, but do need to be some kind of defensive back (It is extremely rare that a defensive coordinator would rely upon a linebacker to have a deep-half or deep-MOF

responsibility. In Tampa 2, middle linebackers can deny the MOF but aren't themselves deep safeties as Tampa 2 is still a split-safety concept).

Shell Identification

For purposes of identifying the shell we need to identify the two column players and the two safeties. After identifying the safeties as laid out above, we evaluate their relative position eight tenths of a second into the play. The safeties are evaluated by their positions at this point because defenses will frequently disguise coverages prior to the snap. In cases where defenses do disguise their coverages and "roll" or "rotate" their coverages, they must do so immediately after the snap. Because deep safeties are by definition separated from potential offensive threats by a buffer of space, looking at the position of the safeties eight tenths of a second into the play gives a snapshot allows us to observe safety rotations after they have occurred but before the locations of the safeties have been skewed by vertical receiving threats. The depth and the angle formed between the two safeties at this point determines if the defense takes on a one-high or a two-high structure. If the angle formed between the safeties is shallow (and the safeties are both above 7 yards), then defense has taken on a 2-high, split-safety structure. If the angle is steeper (or if the lower safety is below 7 yards), the defense has taken on a 1-high, middle-closed structure.

The angle to determine the structure varies based on a few factors, most importantly the difference in the number of defenders and number of offensive players in the column and alley on one side of the ball. Ultimately, a safety is simply a deep player who is an "extra" hat in coverage. Consider a play where the offense is in a 2x2 set, with two detached receivers on each side of the ball. As such, the defense needs to allocate at least two players to detach and play coverage on those two receivers. A "safety" is simply an additional player who gives the defense a numbers advantage in the deep part of the field. So if a team is playing with two-high safeties, they have a 1-man advantage on both sides of the field vs. the proposed 2x2 set. Conversely, a team playing with 1-high safety will typically put him in the middle of the field,

giving the defense an advantage over the middle, but leaving numbers even on the perimeter. As such, if the defense has a numbers advantage in the column and alley on both sides of the field, they are more likely to be playing split-safety. Consequently, we allow for more wiggle room in the safety angle if the defense has a numbers advantage on both sides (allowing for steeper angles between the safeties).

After the safety structure is determined, we then identify the depth of the cornerbacks. This is important for distinguishing between Cover 2, 4, and, 6, as both corners are deep in Cover 4 (likely to play deep quarters), both low in Cover 2, and one high one low in Cover 6. Corner depth is less relevant for one-high structures, as corners can play a deep third from a shallow alignment (although they are less likely to from that depth). Upon visual inspection, the algorithm is quite consistent and effective at determining the shell.

Individual Coverage Labels

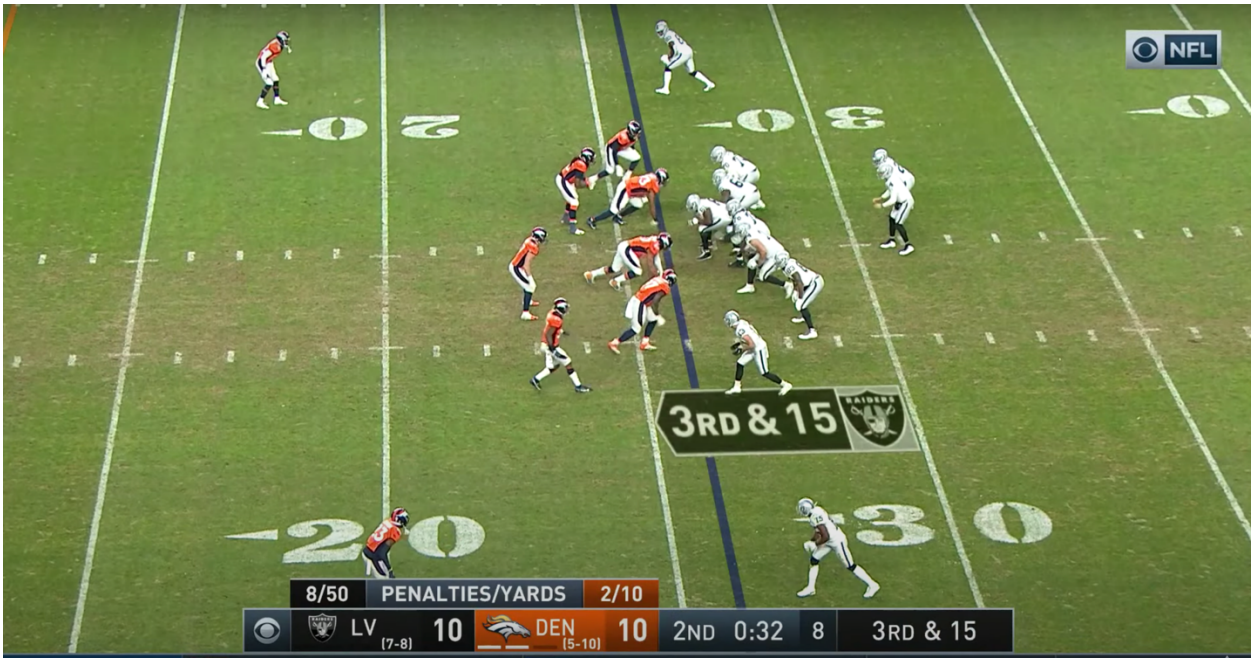
After we determine the shell, we utilize the man/zone coverage labels and number of pass rushers to determine the specific coverage. Corners and safeties follow different rules.

For corners, we follow the "AEIOU" system that some receivers use for CB coverage ID:

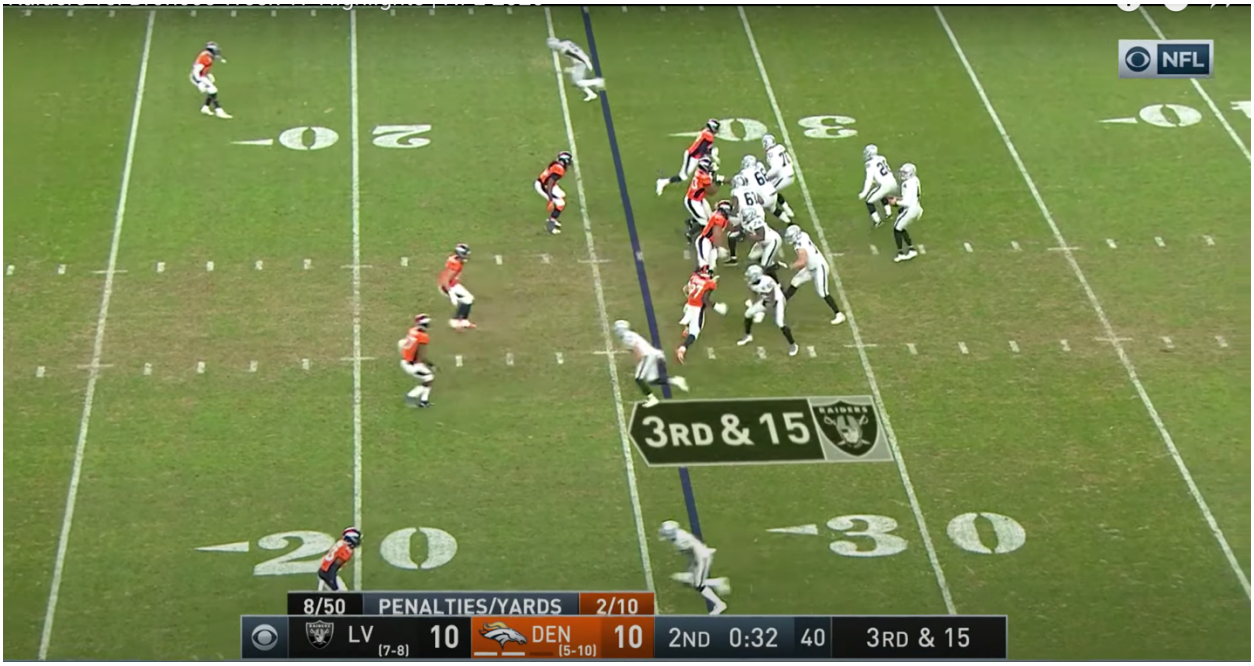
Alignment: This refers to the corner's lateral position on the field. If a corner is more than 10 yards laterally from his nearest teammate, and is less than 9 yards off the ball, he must be in man. 10 yards to the left or right is too much space for any defender to cover in coverage without being in man (ie: in Cover 3, the corner can't pass off the post and become the wheel player on a switch if he is 10 yards away from the slot/conflict defender). Furthermore, a corner's leverage relative to the receiver is important, with inside leverage indicating a high probability of man.

Eyes: If a player is staring directly at the player across from them at the snap, they are likely to be in man. Corners must face squarely at the player across from them or else they will lose the rep (with such little time to react, CBs have to be looking right at the receiver if they have to respect any move in man). Because this is such a dead giveaway, corners will frequently

disguise man and zone by facing the quarterback, and then immediately turn to face the receiver post-snap.



Both corners face the quarterback pre-snap to bluff zone.



Both corners turn to face their respective and play man immediately after the snap.

Intent: Does the player's body language look like he is going to press and play man or bail to play zone. We can't evaluate this from the data provided.

Off: If a corner is backed off the line of scrimmage, he is more likely to play zone, as he can expand his vision to play other routes. If he is more than 9 yards off the line at the snap, he cannot play man, as he is simply too far to respect all possible moves by the receiver.

Up: If a corner is at the line of scrimmage, he is more likely to press and play man, as his vision is restricted.

For safeties, we follow a slightly different approach. If the shell ID has determined that a player is a deep safety, responsible for a deep-half/third/quarter/middle zone, he must be a zone defender. If he is close enough to his nearest offensive player and is facing toward the receiver a few tenths of a second after the snap, he is in man.

Coverage Label Glossary

- Cover 0: An all-out blitz defined by man coverage and zero extra players in coverage/deep safeties.
- Cover 1: A man coverage with a single-high safety structure (low safety is in man or is a “robber” (extra underneath zone defender).
- Cover 2: A zone coverage with two high safeties and low, zone corners who play the flat.
    - 2 Lock: Cover 2 except one of the corners is in man, not zone
    - Cover 42: “Four under, two deep.” Cover 2 but with only six defenders.
    - Cover 28: Cover 2 but with an extra (eighth) coverage defender.
    - 28 Lock: Cover 28 but with one corner in man
- Cover 3: A zone coverage with a single-high safety and zone corners
    - 3 Lock: Cover 3 but with one corner in man
    - Cover 33: “Three under, three deep.” Cover 3 but with only six defenders.
    - Cover 33 Lock: Cover 33 but with one corner in man
    - Cover 38: Cover 3 but with an extra (eighth) coverage defender
    - 38 Lock: Cover 3 but with an extra (eighth) coverage defender
    - 38 Man: Cover 1 but with 8 coverage defenders (both corners in man)
- Cover 4: A zone coverage with two high safeties and high, zone corners who play deep quarters.
    - 4 Lock (aka “4 Key”): Cover 4 but with one corner in man
    - Cover 24: “Two under, four deep” Cover 4 but with only six coverage defenders
    - Cover 24 Lock: Cover 24 but with one corner in man (remaining DBs play deep quarter, quarter, half)
    - Cover 48: Cover 4 but with an extra (eighth) coverage defender
    - Cover 48 Lock: Cover 48 with one corner in man

- Cover 5: “Man under, 2 deep.” Both corners play man, with 2 high safeties in zone.
- Cover 6: Zone coverage with both corners in zone and 2 high safeties playing zone. One corner is shallow playing the flat (the Cover 2 side), the other plays a deep quarter (the Cover 4 side)
    - Cover 66: Cover 6 but with only six coverage defenders
    - Cover 68: Cover 6 but with an extra (eighth) coverage defender

Data Description

We collected publicly data on player salary and NFL combine measurables from various web sources, including nflcombineresults.com and the following Google Drive page: https://docs.google.com/spreadsheets/d/138OefECeaMDXX-a0QvYoH0zI7TKOOapKHpcZdmjSPlY/edit#gid=1418500202

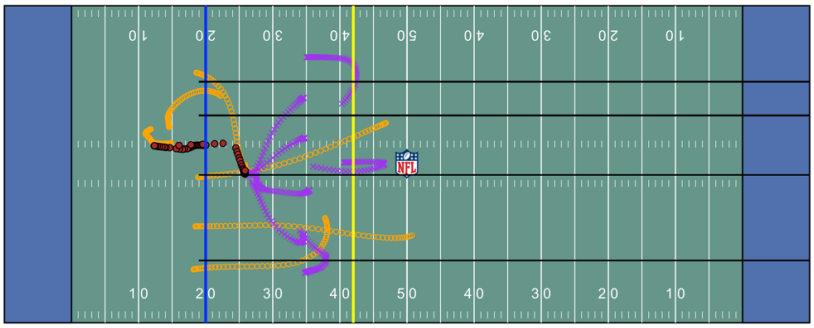
For salary data, we used Spotrac.com. We tried to make the data as robust as possible, but even still our data is not complete for every single player. We believe that with better data (that an NFL franchise may have access to), even more robust results may be found.

Special Thanks:

- Dave Caputi: Offensive Coordinator/Offensive Line Coach, Middlebury Football Team
- Danny Payne: Director of Scouting and Analytics, Army Football Team
- Aumit Leon

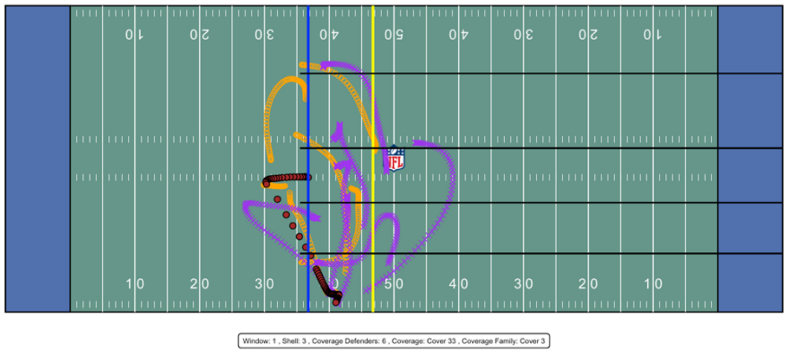
Select Visualizations

Week: 1 Game: 2018090600 Play: 2575
Quarter: 3 Down: 3 To Go: 22 Time: 10:57:00



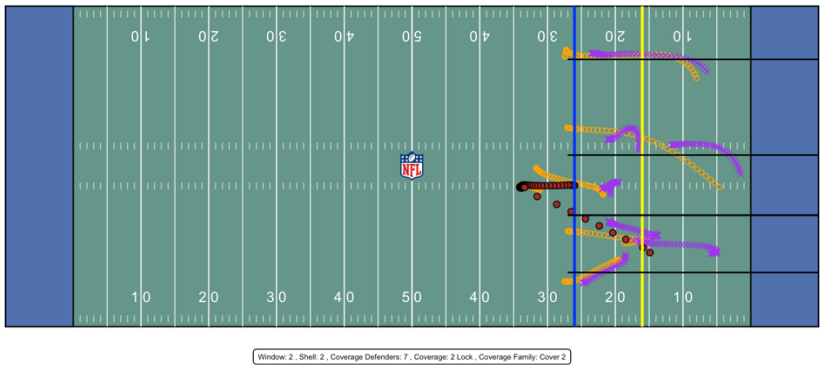
(10:57) (Shotgun) M.Ryan pass short middle to J.Jones to ATL 26 for 6 yards (J.Hicks).

Week: 1 Game: 2018090600 Play: 2624
Quarter: 3 Down: 1 To Go: 10 Time: 10:11:00



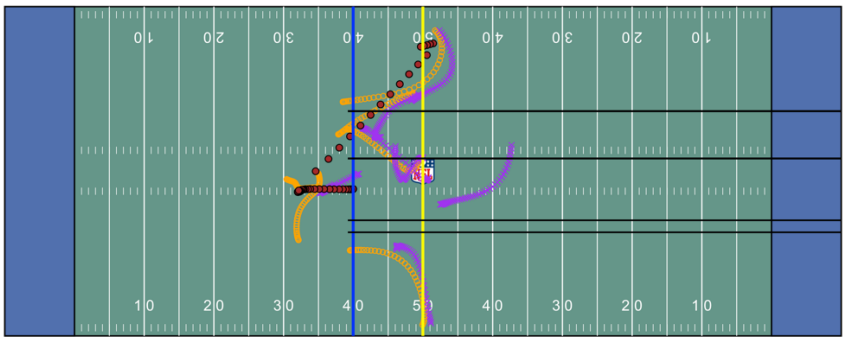
(10:11) (Shotgun) N.Foles pass short right to D.Goedert to PHI 41 for 4 yards (R.Allen, D.Jones).

Week: 1 Game: 2018090600 Play: 2764
Quarter: 3 Down: 1 To Go: 10 Time: 06:46:00



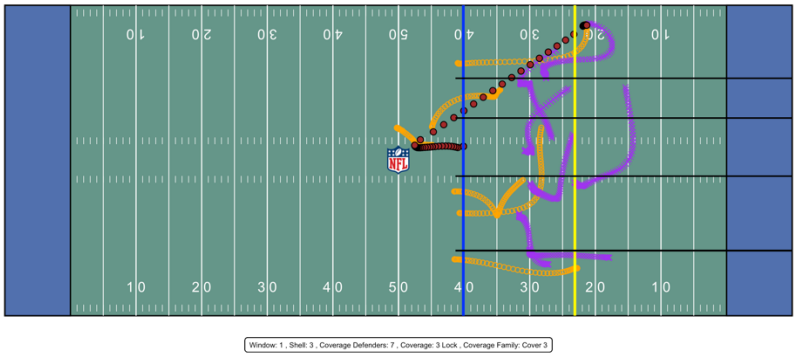
(6:46) (Shotgun) N.Foles pass incomplete short right to Z.Ertz.

Week: 1 Game: 2018090600 Play: 3004
Quarter: 3 Down: 3 To Go: 10 Time: 02:48:00



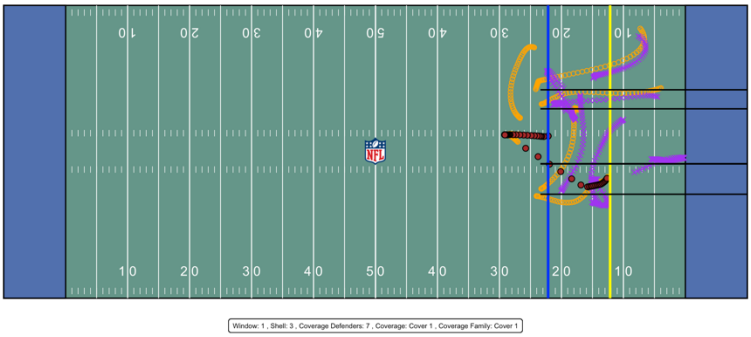
(2:48) (Shotgun) M.Ryan pass incomplete short left to J.Jones (R.Darby).

Week: 1 Game: 2018090600 Play: 4258
Quarter: 4 Down: 3 To Go: 17 Time: 01:25:00



(1:25) (No Huddle, Shotgun) M.Ryan pass deep left to J.Jones to PHI 22 for 18 yards (R.Darby) [C.Long].

Week: 1 Game: 2018090600 Play: 4282
Quarter: 4 Down: 1 To Go: 10 Time: 01:18:00



(1:18) (Shotgun) M.Ryan pass short right to J.Jones to PHI 13 for 9 yards (J.Mills).