Sports Info Solutions Football Analytics Challenge 2021

MFANS Submission - Arjun Menon, Conor McQuiston, and Joey DiCresce

Problem Statement

Which route combinations were most popular in the NFL in 2020? Of these route combinations, which perform best against each coverage type?

Approach

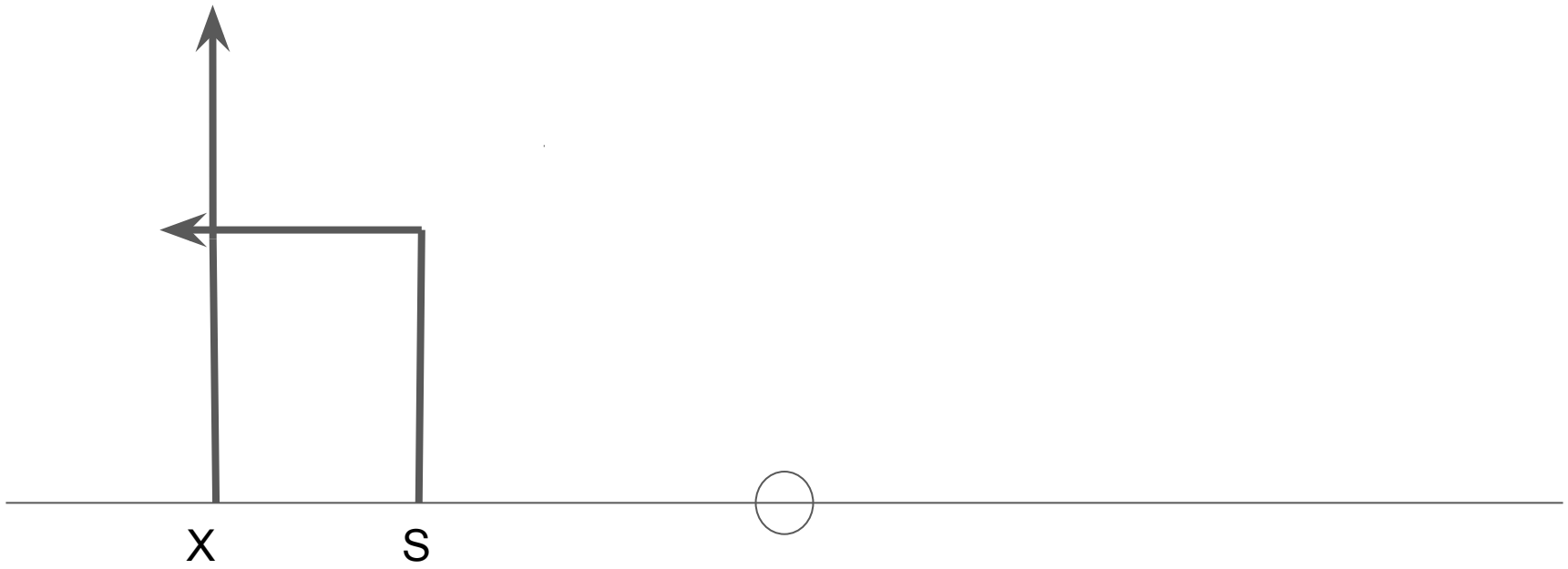
1. Define well-established route concepts
2. Investigate individual counts/successes of those concepts
3. Cluster Concepts/Playcalling to determine overall trends within the NFL

Categorizing Routes/Concepts

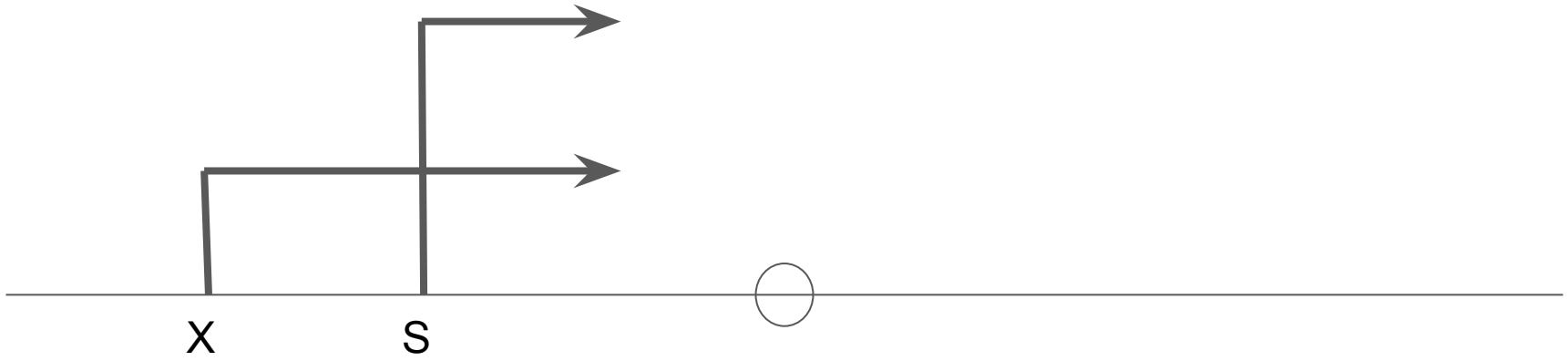
- Passing Concepts were defined on the half field route combination level with several whole field concepts defined
- Sides of the field with a single receiver were defined by that receiver's route and unnamed two receiver route combinations were named by a "Outside Route - Inside Route" schema
- Nearly 85% of all passing plays could be categorized with this schema
    - Exhaustive list can be found in Appendix

Which Route Concepts were Most Popular in the NFL in 2020?

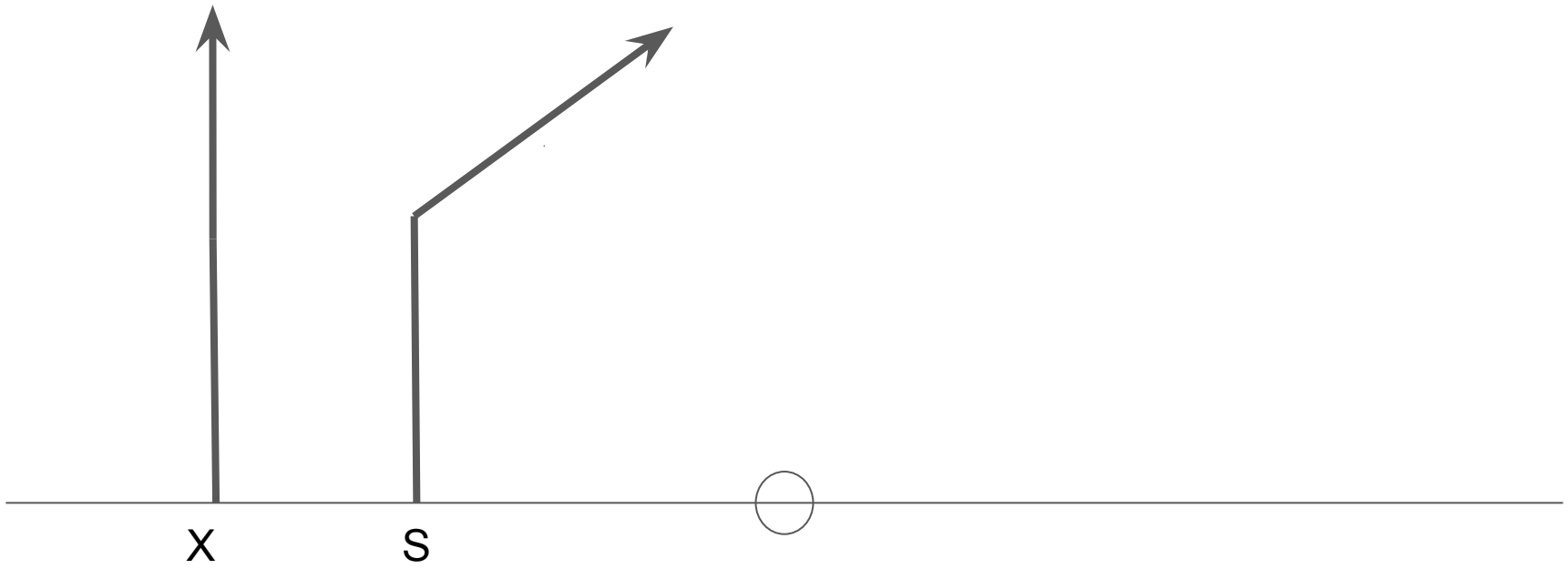
#1 - Flood (Called on 4.9% of All Pass Plays)



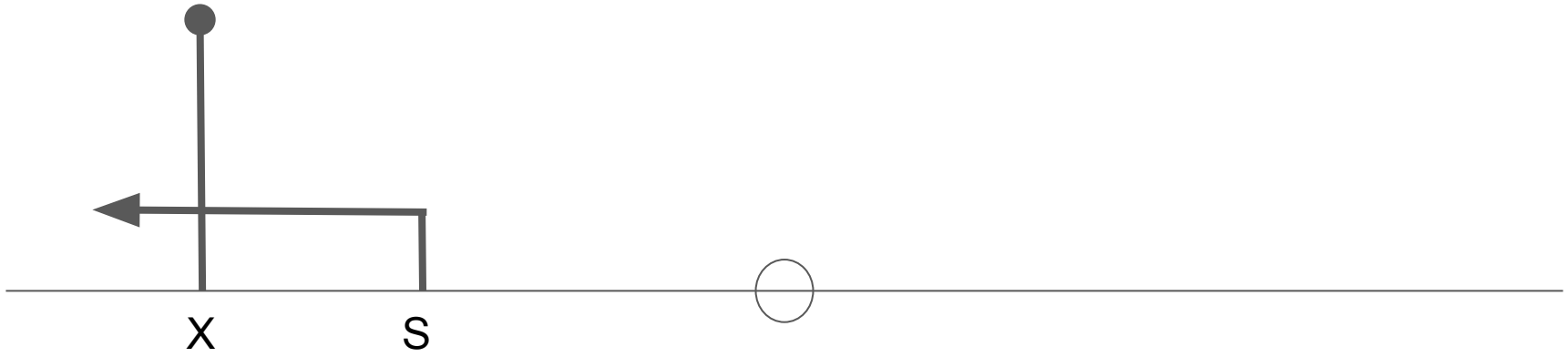
#2 - Hi-Lo (Called on 4.85% of All Pass Plays)



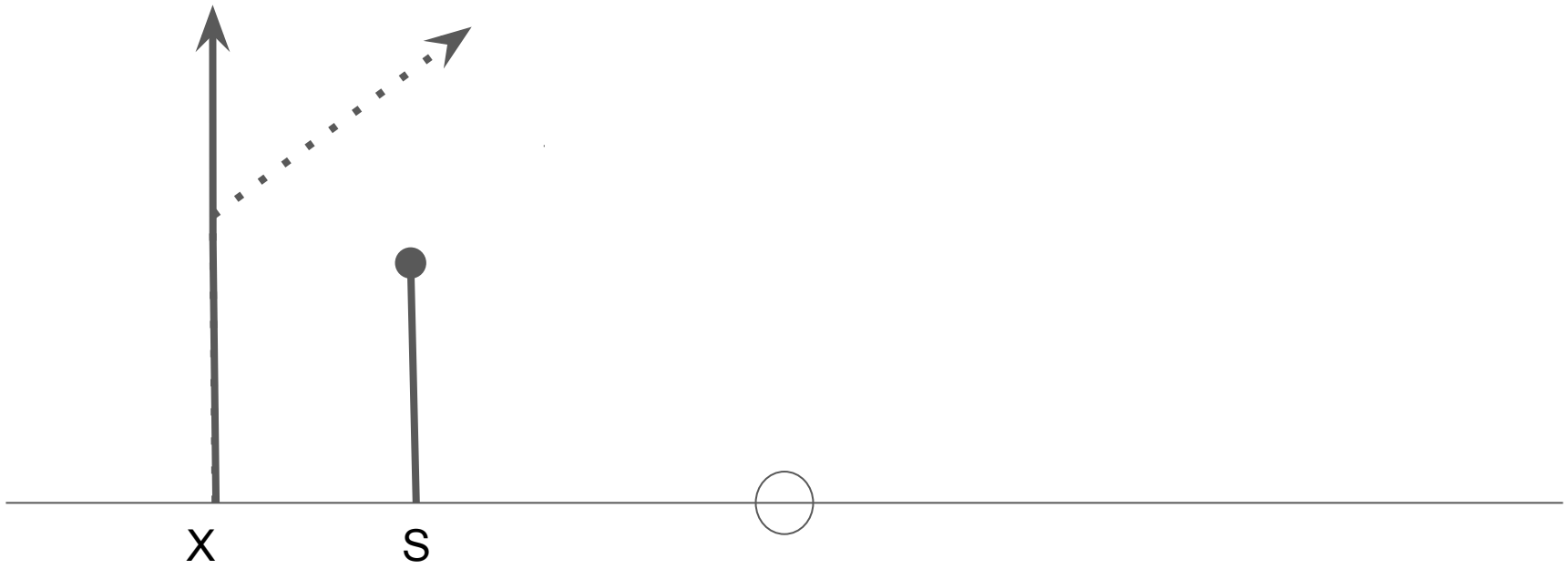
#3 - Divide (Called on 4.7% of All Pass Plays)



#4 - Curl Flat (Called on 4.15% of All Pass Plays)



#5 - Shock (Called on 4.15% of All Pass Plays)



Clustering

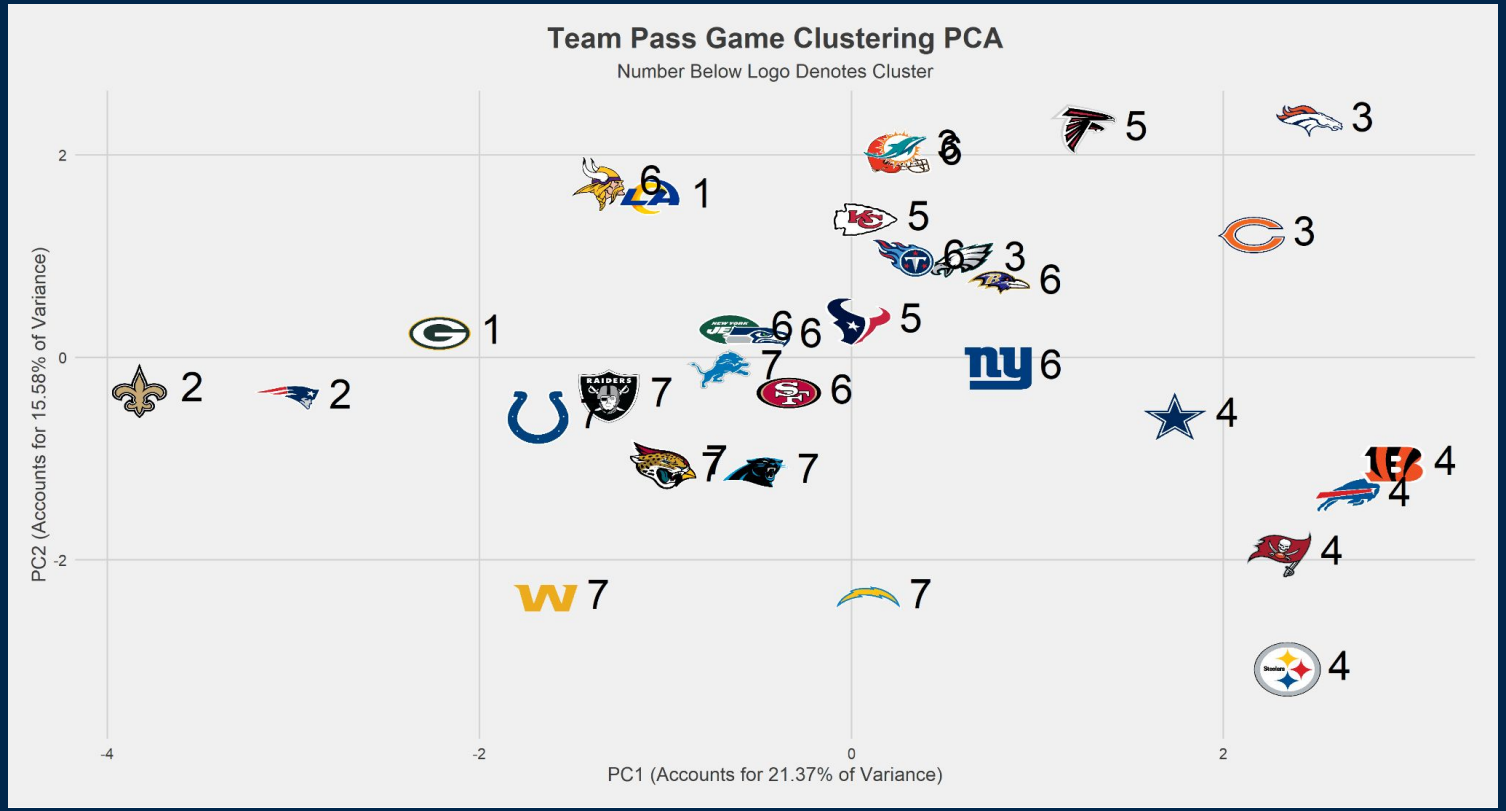
Since passing concepts typically play a specific role in each offensive philosophy, we ought to be able to cluster NFL teams into families.

This will allow us to see overall trends in the NFL and ascertain strengths and weaknesses of each group of passing concepts

Clustering Approach

- NFL teams were clustered into 7 groups using a K-Means algorithm with the following features:
  - # of Concepts Targeted more than 10 times
  - # of Times each of the most common concepts (along with WR Screens & All Verticals) were targeted
  - aDOT
  - RPO Rate
  - Quick Game Drop Rate (0-3 Steps)
  - Deep Drop Rate (5-7 Steps)
  - Designed Rollout Rate

NFL Team Clusters

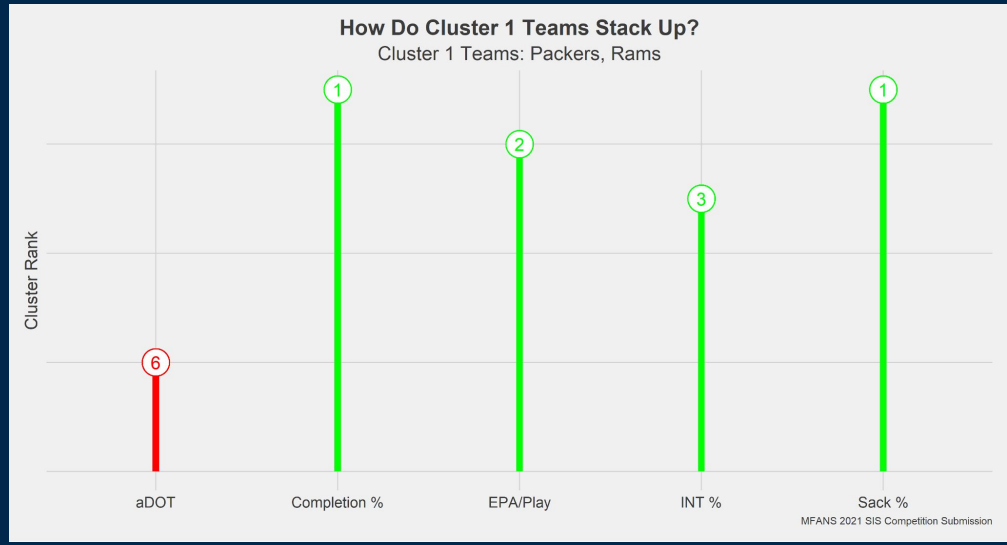


Cluster 1

Rams, Packers

Top 5 Most Targeted Concepts: Cluster 1

Concept	Target Rate	EPA/Play	aDOT	INT %
WR Screen	12%	0.02	-1.88	0%
Hi-Lo	7.4%	0.14	5.39	3.57%
Flood	6.7%	0.31	10.94	0%
Cross-7	4.7%	-0.01	3.31	5.56%
Divide	4.3%	0.60	12.21	3.03%



Cluster 1

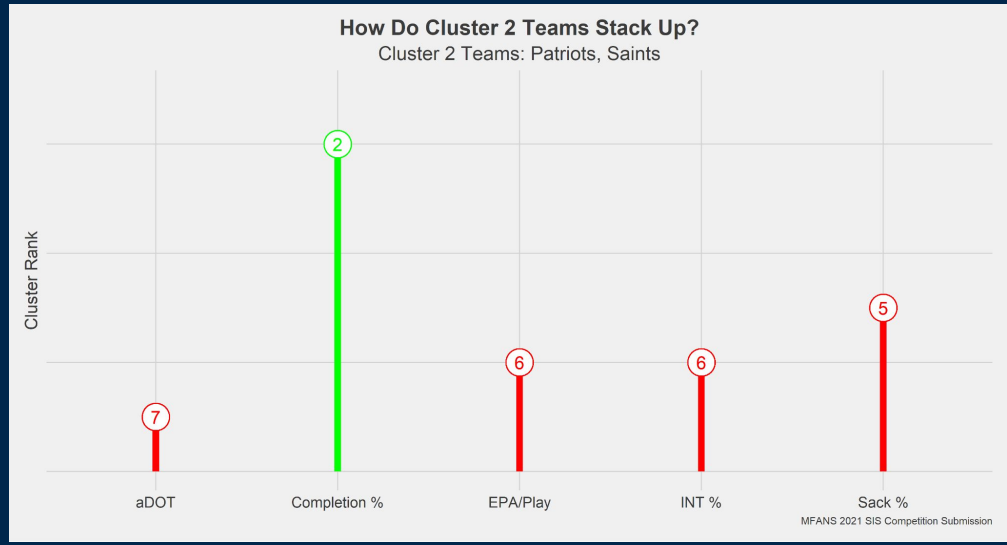
- Pros
  - Lots of Moving Pockets = Low Sack Rate
  - Hi-Lo and Flood emphasis makes QB’s life easy
- Cons
  - Does not stretch defense vertically
  - Small number of concepts can lead to predictability

Cluster 2

Patriots, Saints

Top 5 Most Targeted Concepts: Cluster 2

Concept	Target Rate	EPA/Play	aDOT	INT %
Portland	10.7%	0.08	8.86	6.06%
Flood	8%	0.08	9.59	4.08%
Hi-Lo	6.3%	-0.35	6.41	5.13%
Curl	5.8%	0.33	7.03	0%
WR Screen	5.8%	-0.12	-3.25	0%



Cluster 2

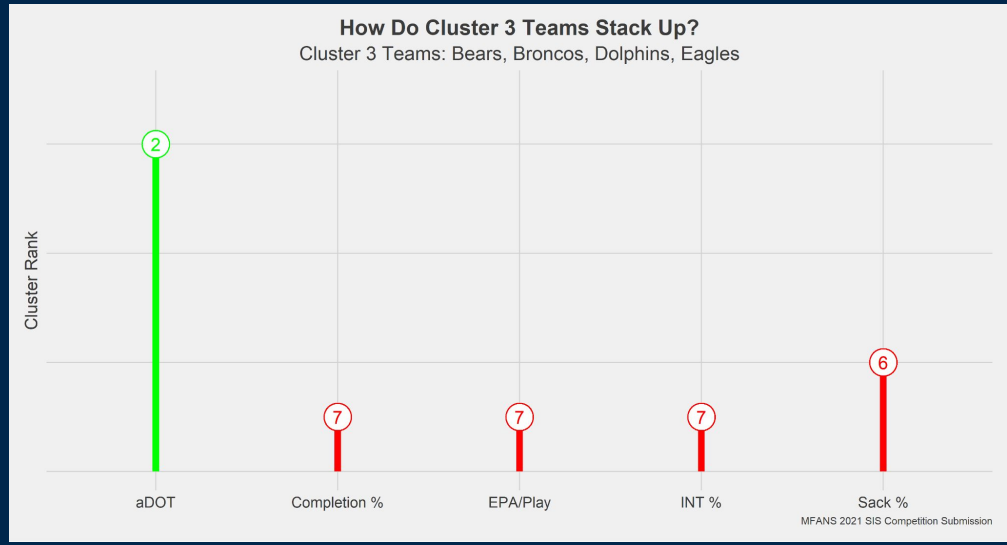
- Pros
  - Emphasis on easy reads boosts completion percentage
  - Heavy Portland usage stresses MOF
- Cons
  - Lots of deep drops require OL to hold up for longer
  - Extremely small amount of focus concepts lends itself to predictability

Cluster 3

Bears, Broncos, Dolphins, Eagles

Top 5 Most Targeted Concepts: Cluster 3

Concept	Target Rate	EPA/Play	aDOT	INT %
Flood	7.3%	0.14	9.82	3.31%
Hi-Lo	7%	-0.10	6.21	3.48%
Vertical	5%	0.07	21.52	8.54%
Cross-7	4.5%	0.07	6.84	0%
Portland	4.5%	-0.19	12.54	1.35%



Cluster 3

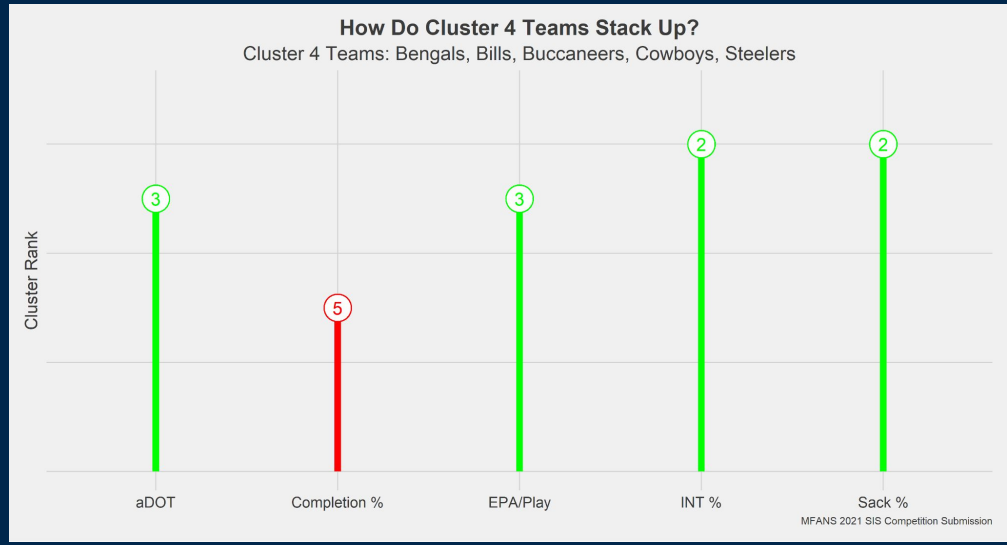
- Pros
  - Stretches Defenses Vertically
  - Hi-Lo and Flood concepts simplify QB reads
- Cons
  - Vertical passing inflates sack rate, even with lots of movement drops
  - Can easily be derailed by bad QB play

Cluster 4

Bengals, Bills, Buccaneers, Cowboys, Steelers

Top 5 Most Targeted Concepts: Cluster 4

Concept	Target Rate	EPA/Play	aDOT	INT %
WR Screen	7.2%	0.13	-1.75	0%
Divide	5.6%	0.28	15.06	2.42%
Shock	4.7%	0.30	10.98	0.95%
Flood	4.6%	0.04	11.45	0.97%
Portland	4.6%	0.28	13.59	0.98%



Cluster 4

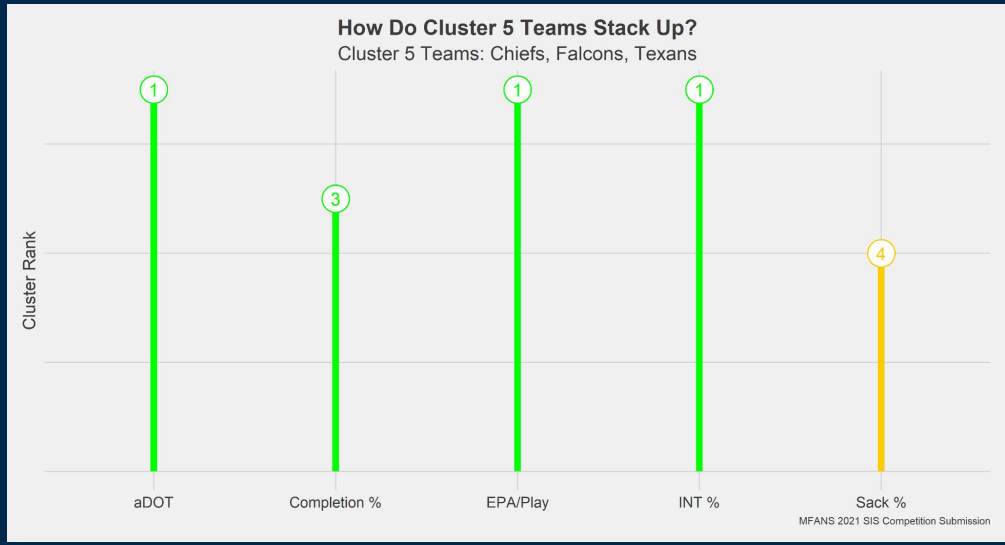
- Pros
  - Adaptable to strong arm QBs and those who rely on timing and accuracy
  - Abundance of Quick Game Drops keep QBs clean
- Cons
  - Vertical stretching can limit completion percentage

Cluster 5

Chiefs, Falcons, Texans

Top 5 Most Targeted Concepts: Cluster 5

Concept	Target Rate	EPA/Play	aDOT	INT %
Curl Flat	8.2%	0.29	7.57	0%
Portland	5.5%	-0.10	10.74	1.43%
Flood	5.3%	0.55	14.38	0%
Hi-Lo	5.3%	0.18	4.99	0%
Shock	5.3%	0.51	12.38	0%



Cluster 5

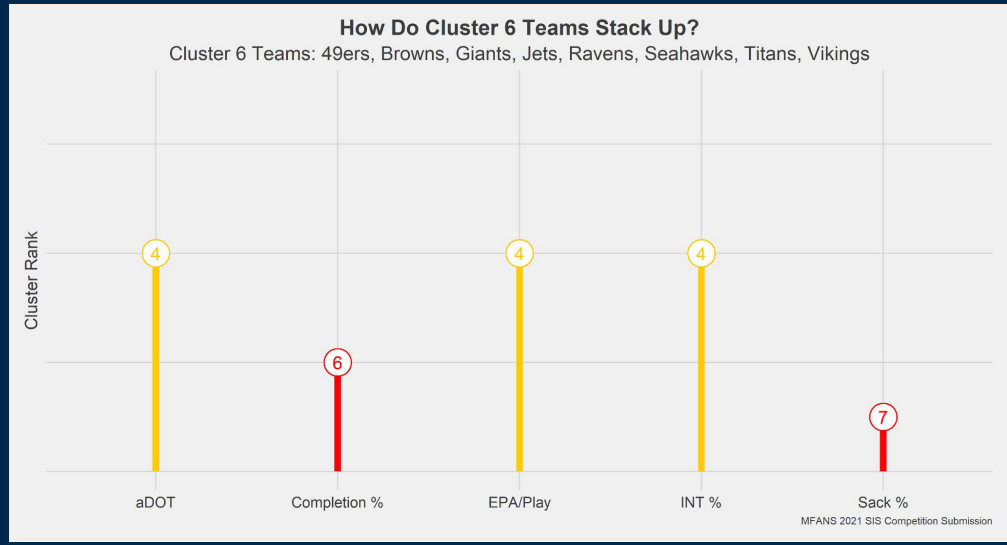
- Pros
  - High RPO rate stresses Defenses' conflict points
  - Curl-Flat emphasis can help get playmakers in space
- Cons
  - Heavy Curl-Flat usage is potentially susceptible to Man
  - Reliance on strong QBs can lead to high sack rate

Cluster 6

49ers, Browns, Giants, Jets, Ravens, Seahawks, Titans, Vikings

Top 5 Most Targeted Concepts: Cluster 6

Concept	Target Rate	EPA/Play	aDOT	INT %
Portland	5.5%	-0.03	10.02	1.32%
Curl Flat	5.4%	0.29	7.20	0.66%
Flood	5.1%	0.10	9.77	2.82%
Hi-Lo	4.8%	0.12	6.03	2.26%
WR Screen	4.5%	0.06	-1.77	0%



Cluster 6

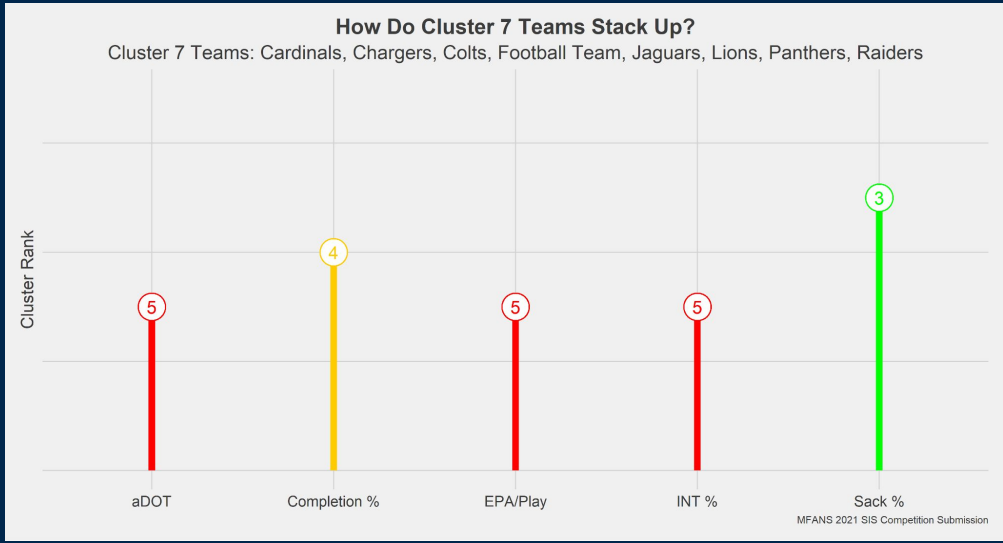
- Pros
  - Implied heavy play action usage helps to freeze defenses
  - High use of moving pockets gives athletic QBs a chance to make a play
- Cons
  - Lower than average pass game diversity can become predictable
  - Low RPO rate keeps defenders out of conflict

Cluster 7

Cardinals, Chargers, Colts, Football Team, Jaguars, Lions, Panthers, Raiders

Top 5 Most Targeted Concepts: Cluster 7

Concept	Target Rate	EPA/Play	aDOT	INT %
WR Screen	8.2%	0.04	-2.31	0%
Portland	6.5%	-0.09	12.68	2.43%
Curl Flat	5.1%	-0.05	7.23	2.48%
Flood	4.6%	0.20	11.71	2.04%
Divide	4.4%	0.06	16.87	4.96%



Cluster 7

- Pros
  - High Screen usage gets playmakers in space
  - Emphasis on playmakers can mask middling-poor QB play
- Cons
  - Below average Hi-Lo and Flood usage creates more difficult reads
  - Few Quick and Movement drops stresses OL

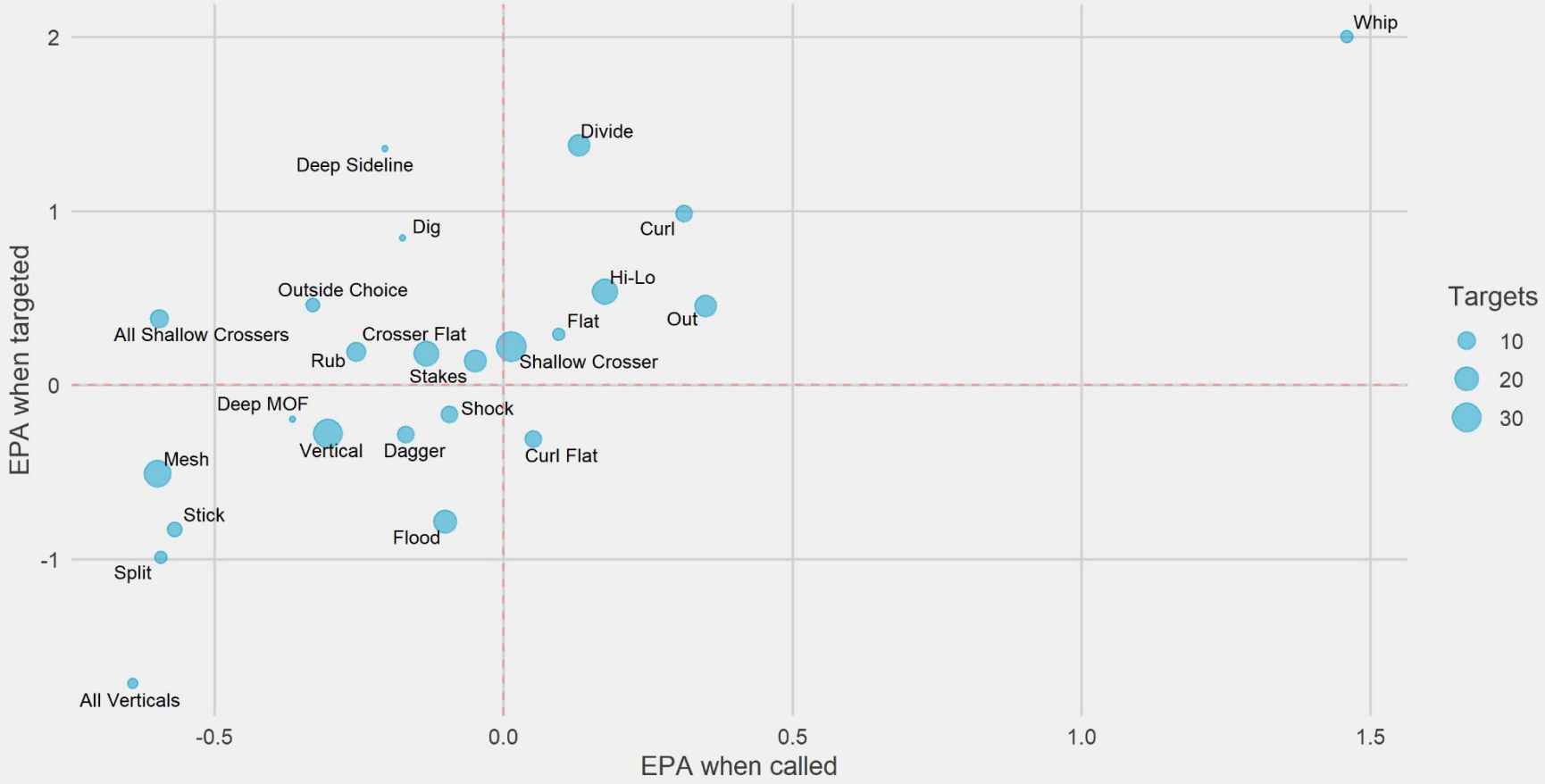
Which Route Concepts Perform Best Against Each Coverage?

Approach

- How do we account for the fact that two concepts can be ran on the same play?
- We look at EPA per play-call and EPA per target for each concept to get more information.
- Plays when the concept is not targeted still give us information
- A combination of EPA per play-call and EPA per target should be used to select the best concepts vs. each coverage. For example
  - High EPA per play-call but low EPA per target may indicate a concept is often ran as a decoy or with other concepts as the primary read
  - Low EPA per play-call but High EPA per target may indicate that a concept is not getting open often causing more sacks which heavily bring down EPA.
  - On the other hand, low EPA per play-call but High EPA per target may indicate that a concept excels against a coverage only if a certain read is made, and if so the concept is targeted.

Concepts vs Cover 0

Minimum 10 plays against Cover 0



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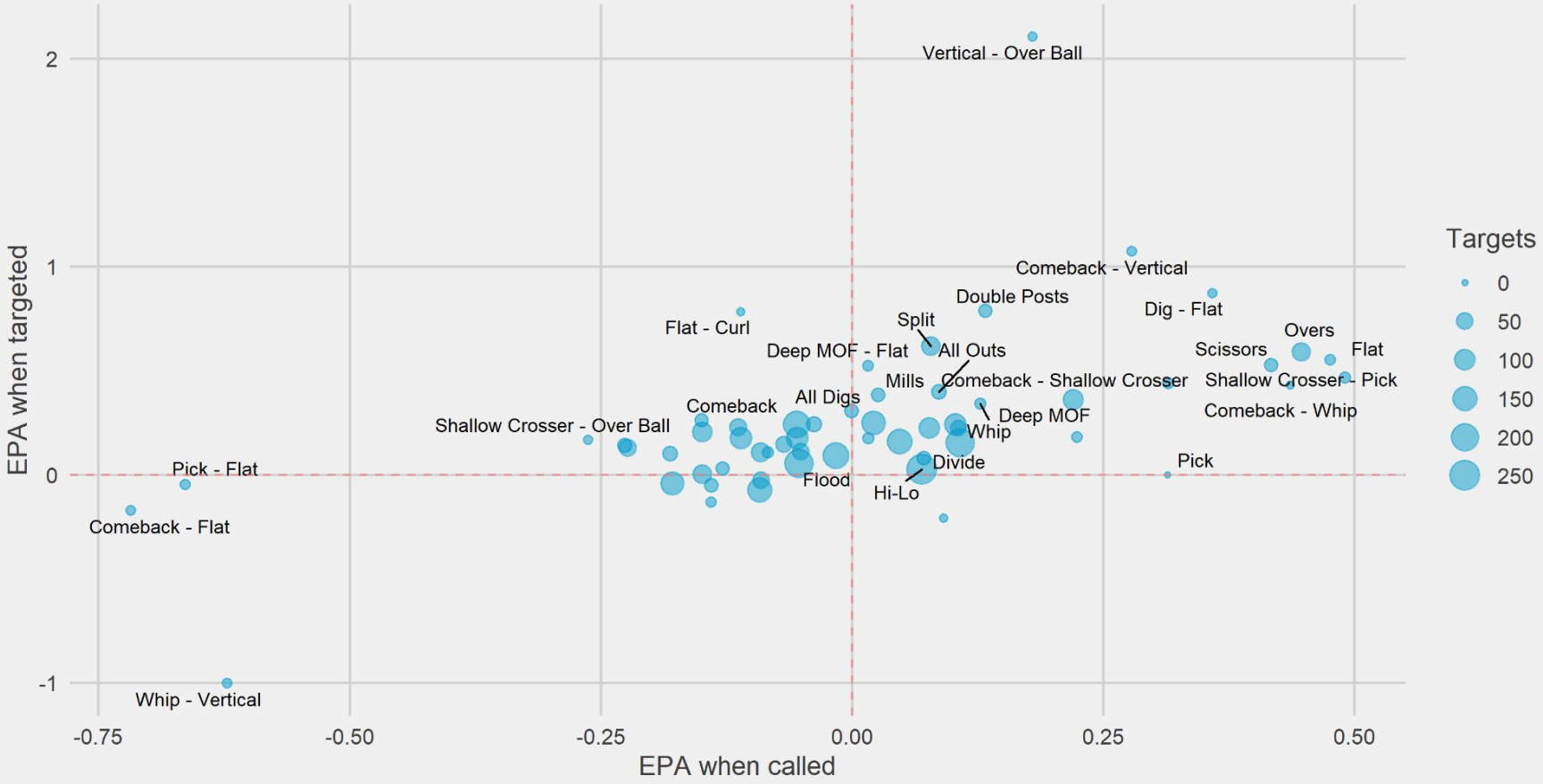
Best Concepts vs Cover 0

- Whip
- Divide
- Curl
- Out

- Whip had the best EPA/play when targeted
  - Cover 0 is an all out blitz with one on one man matchups, so whip can get WRs open quick
- All Verticals had the lowest EPA/play when targeted
  - Considering that vertical routes take a couple seconds to develop, it makes sense that it has the lowest EPA/play when targeted against Cover 0
- Route concepts that are isolated man-beaters generally did well (Shallow cross, out, dig, and curls).

Concepts vs Cover 1

Minimum 10 plays against Cover 1



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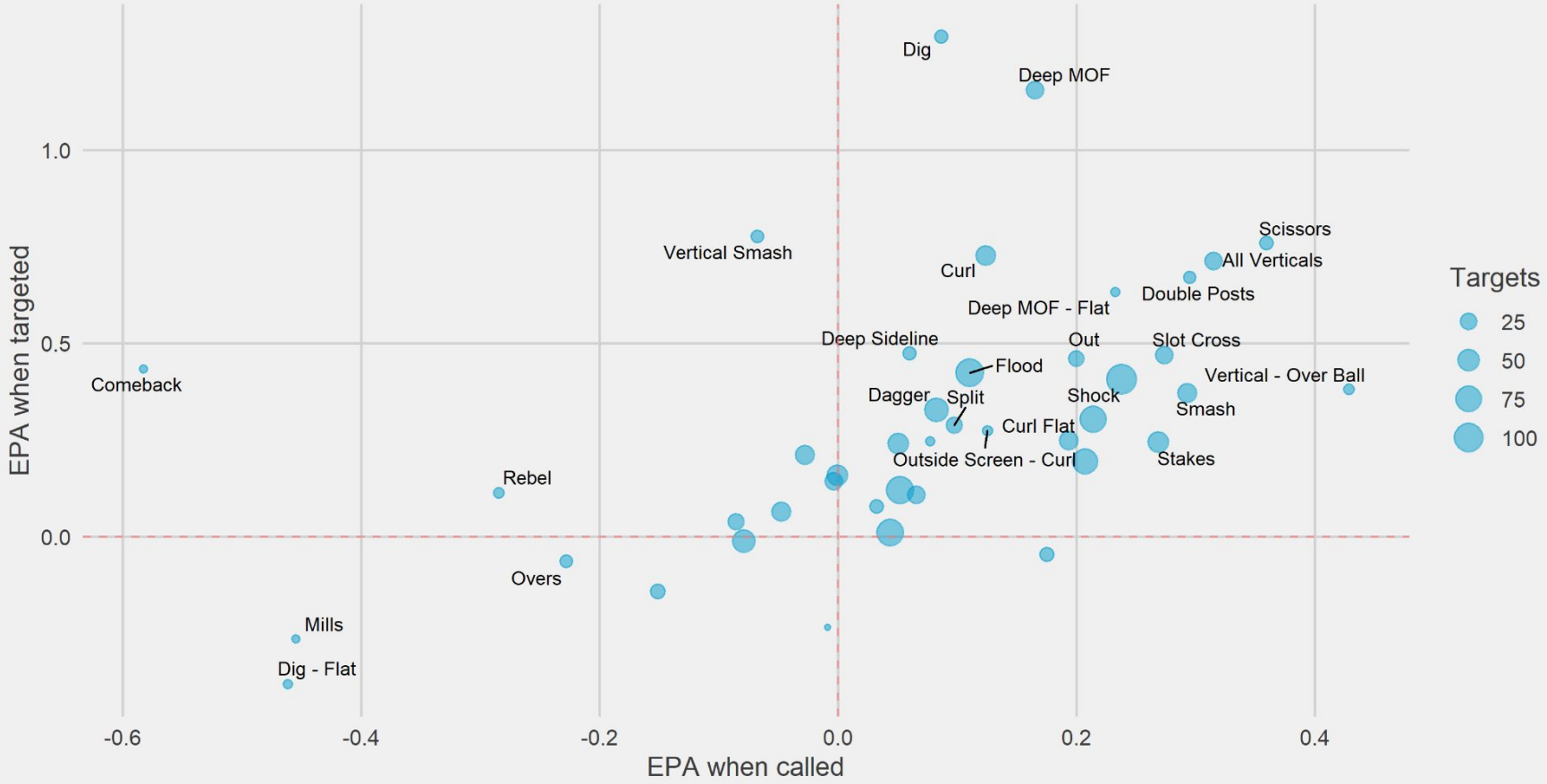
Best Concepts vs Cover 1

- Shallow Crosser - Pick
- Flat
- Overs
- Scissors
- Vertical - Over Ball

- Many of the route concepts ended up having a positive EPA/play when targeted.
- Cover 1 is also a very common defensive play call, meaning there is a larger sample size of the number of times the route concept was targeted
- Routes that cross one another perform well against man, (Overs, Scissors, and Shallow Crosser - Pick)

Concepts vs Cover 2

Minimum 10 plays against Cover 2



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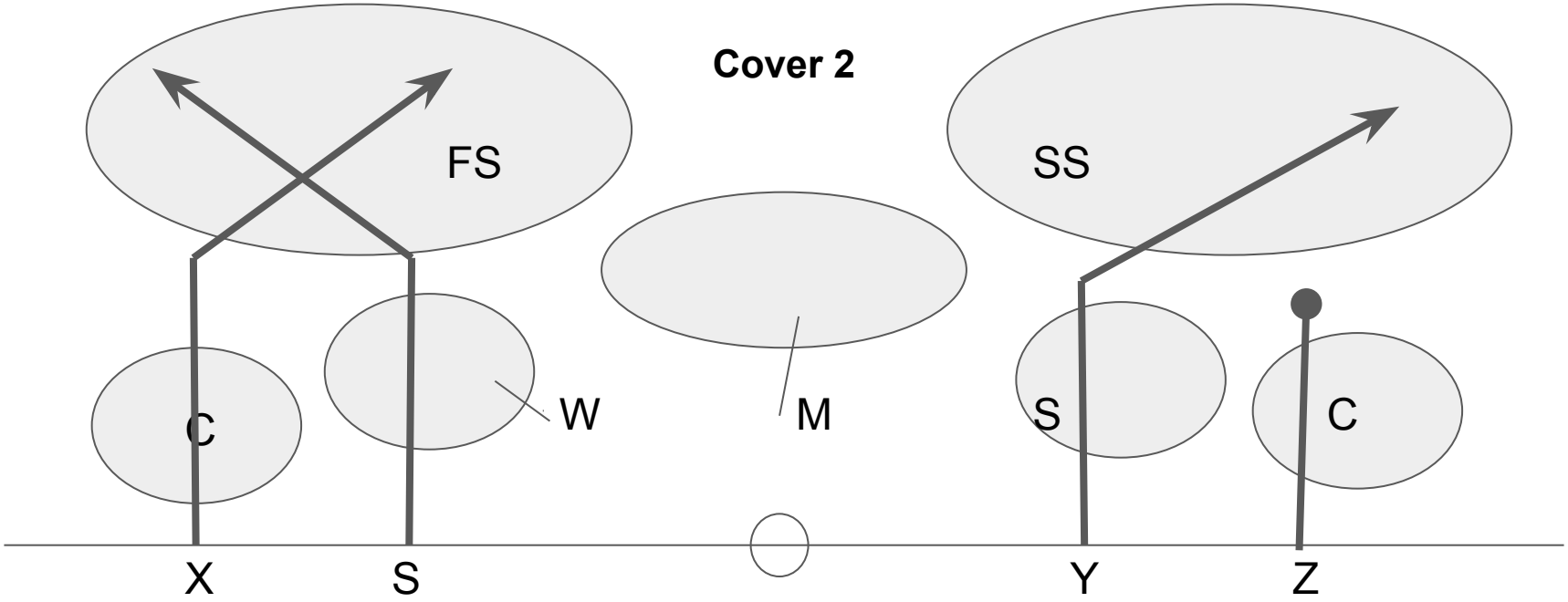
Best Concepts vs Cover 2

- Scissors
- All Verticals
- Double Post
- Smash
- Deep Middle of Field

- In general, the most successful route concepts vs Cover 2 by EPA were routes that were ran over the middle
- The hole in Cover 2 is the gap between the two safeties and behind/in front of the MLB.
- Digs, Deep middle of field, and Vertical smash all resonate with this idea which is why they show up highly when targeted



Scissors

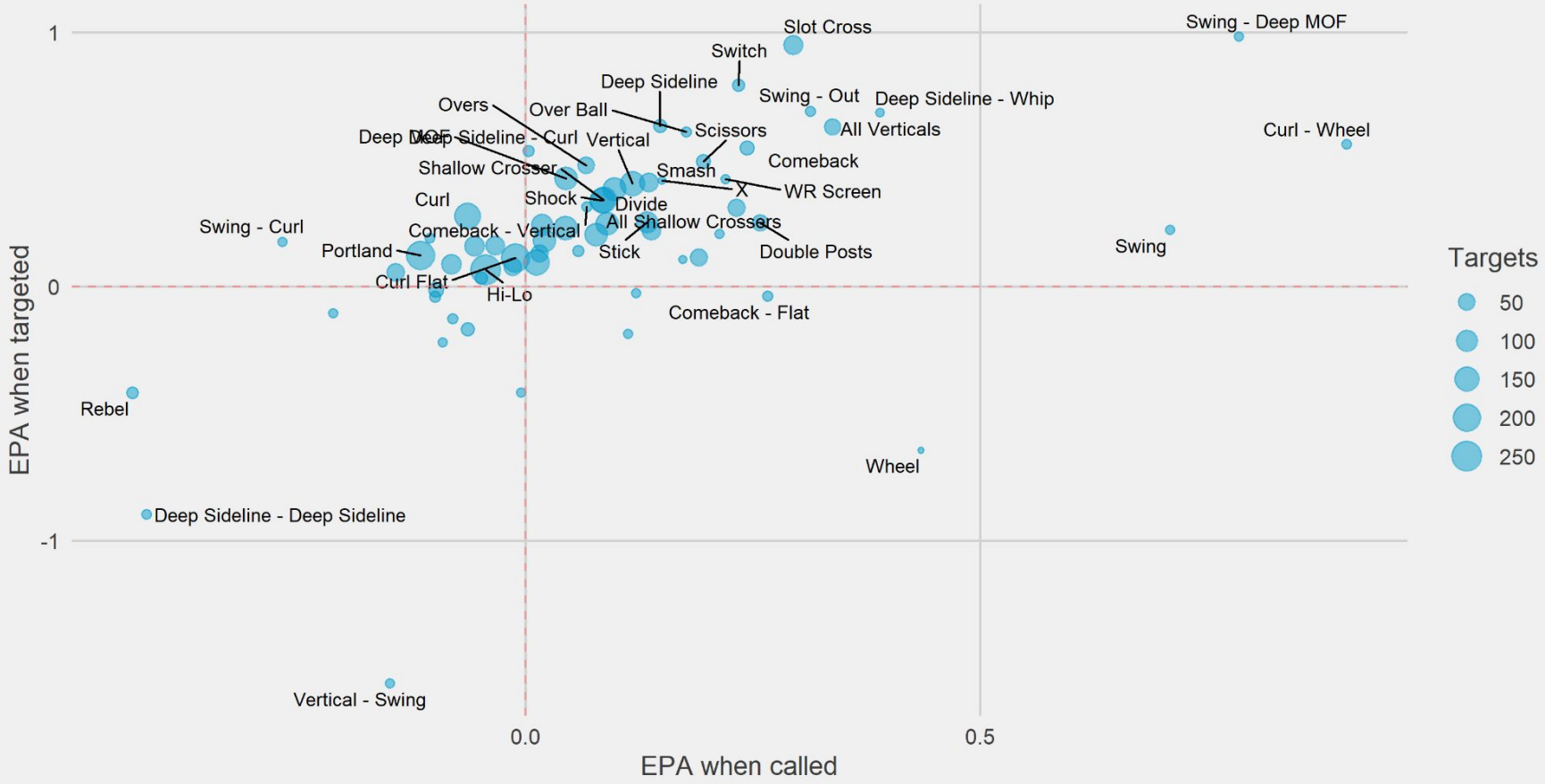
- Post attacks hole in deep middle
- Corner and Post put FS in conflict
- Corner attacks weak spot between FS and CB

Smash

- Curl occupies CB
- Corner route goes over CB and gives Y space to beat SS to the outside

Concepts vs Cover 3

Minimum 10 plays against Cover 3



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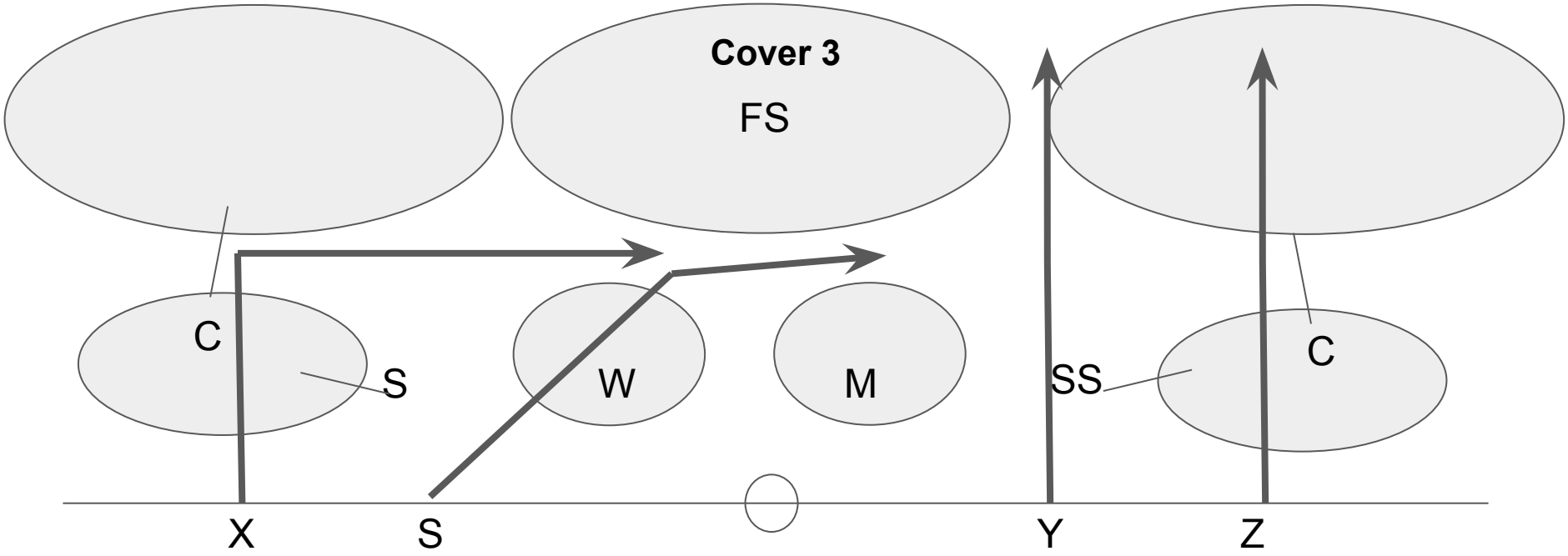
Best Concepts vs Cover 3

- Slot Cross
- All Verts
- Switch
- Comeback
- All Shallow Crossers
- Scissors
- Smash
- Double Post

- Cover 3 is generally a very conservative defense
  - Stops the big plays, but allows a lot of smaller positive plays through checkdowns and swing passes due to the CBs and LBs playing off the line of scrimmage
- As such, many concepts have a positive EPA vs Cover 3, but only 4 concepts that were ran a minimum of 10 times had over a 0.75 EPA/play
- Cover 3 also had the highest number of route concepts run against it

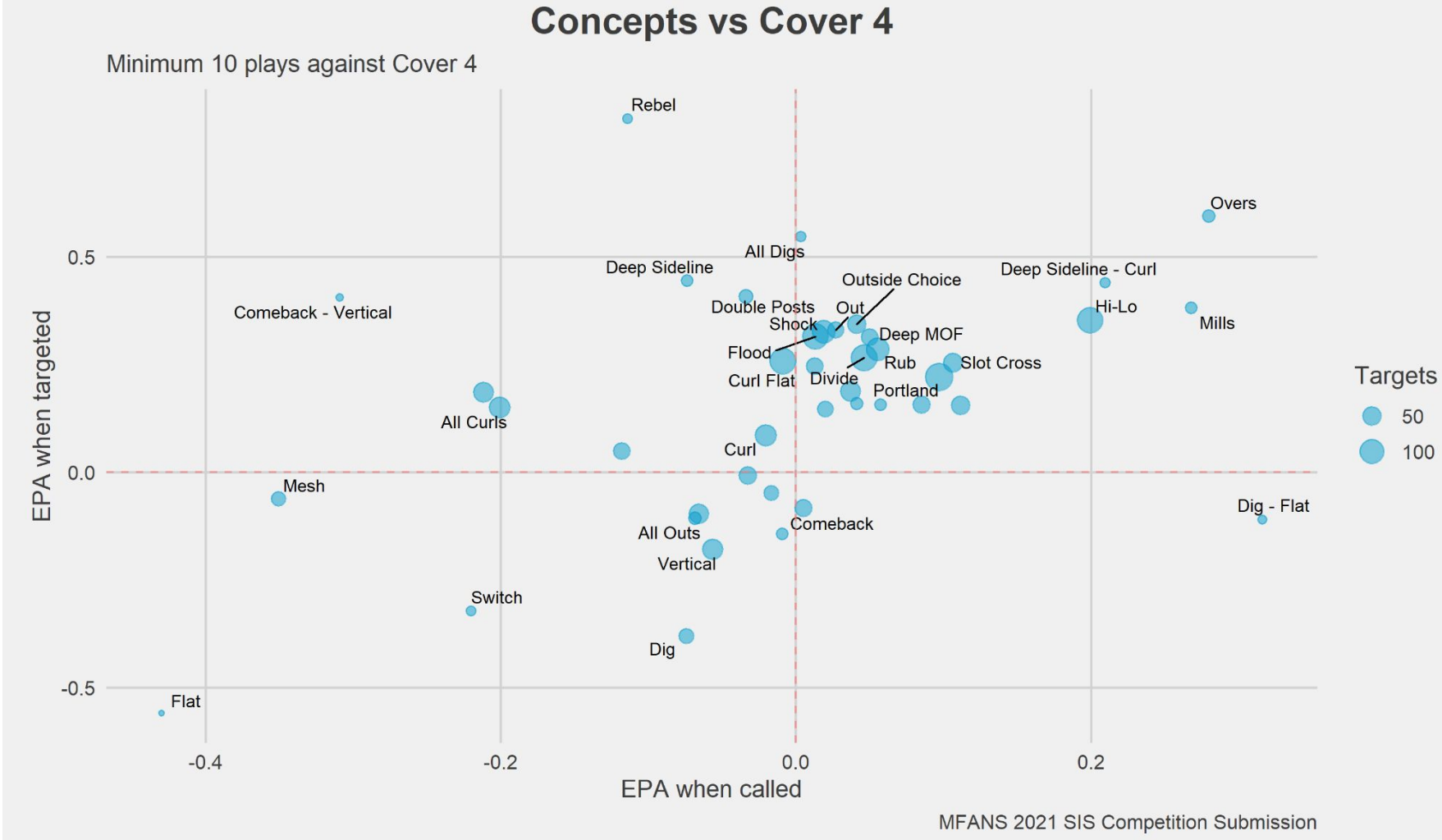


Slot Cross

- Slot runs in hole behind LBs, in front of FS
- Slot clears way for X running a dig
- Attacks less populated middle of the field
- Often attacks LBs rather than DBs

All Verts

- Attacks weak spot in seam between FS and CB
- CB can be put in conflict with two deep routes near zone


Concepts vs Cover 4
Minimum 10 plays against Cover 4
Rebel
Overs
All Digs
Deep Sideline
Deep Sideline - Curl
Outside Choice
Comeback - Vertical
Double Posts
Out
Hi-Lo
Mills
Shock
Deep MOF
Flood
Rub
Slot Cross
Curl Flat
Divide
Portland
All Curls
Curl
Mesh
Dig - Flat
Comeback
All Outs
Vertical
Switch
Dig
Flat
0.5
0.0
-0.5
-0.4
-0.2
0.0
0.2
EPA when targeted
EPA when called
Targets
50
100
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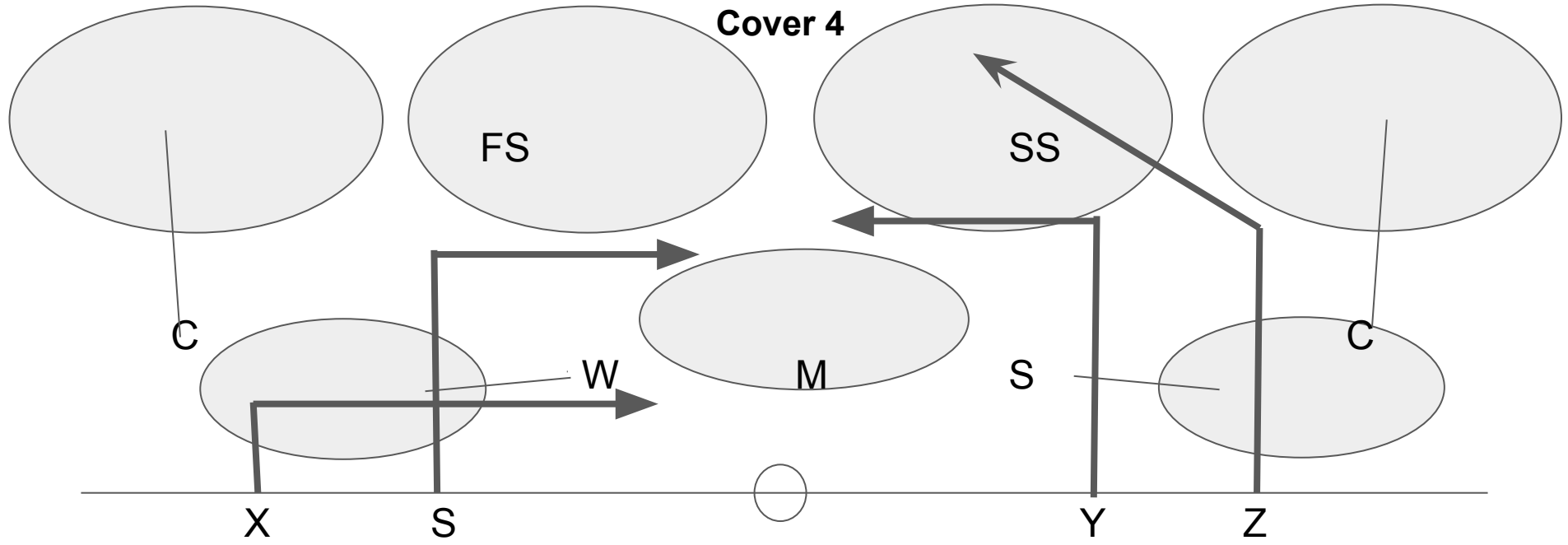
Best Concepts vs Cover 4

- Overs
- Mills
- Deep Sideline - Curl
- Hi-Lo
- Rub
- Slot-Cross
- Outside Choice

- Similar to Cover 3, Cover 4 is a very conservative coverage with 4 deep zones, which limits the big plays an offense can get
- Thus, no route had higher than a 0.7 EPA/play vs Cover 4



Hi - Lo

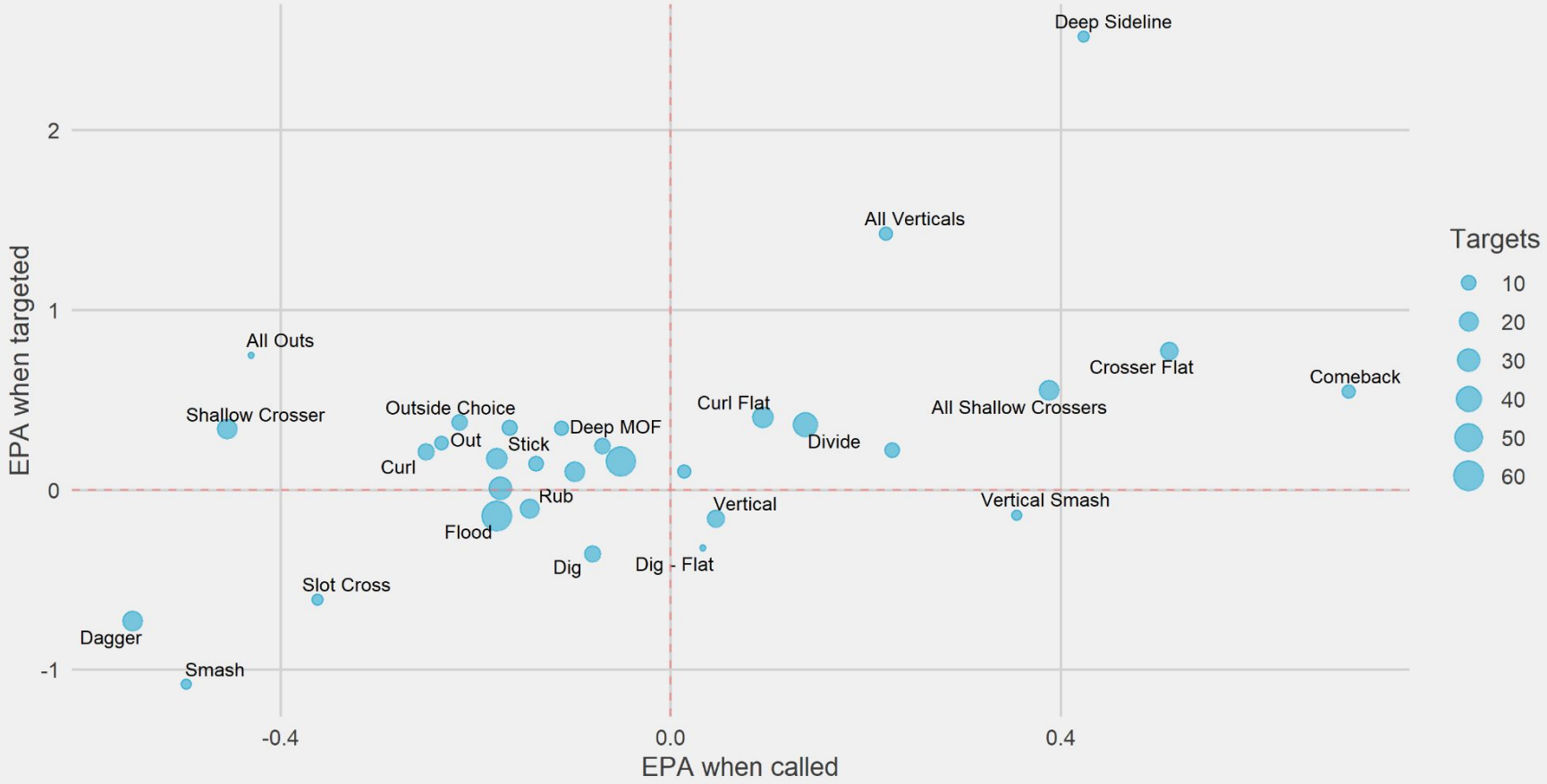
- Choice between “Hi” or “Lo” depending on which route M takes
- Attacks LBs in middle of field with numbers advantage

Mills

- Y Dig brings SS up, leaving space behind open for Z-Post, with leverage on the CB

Concepts vs Cover 2 Man

Minimum 10 plays against Cover 2 Man



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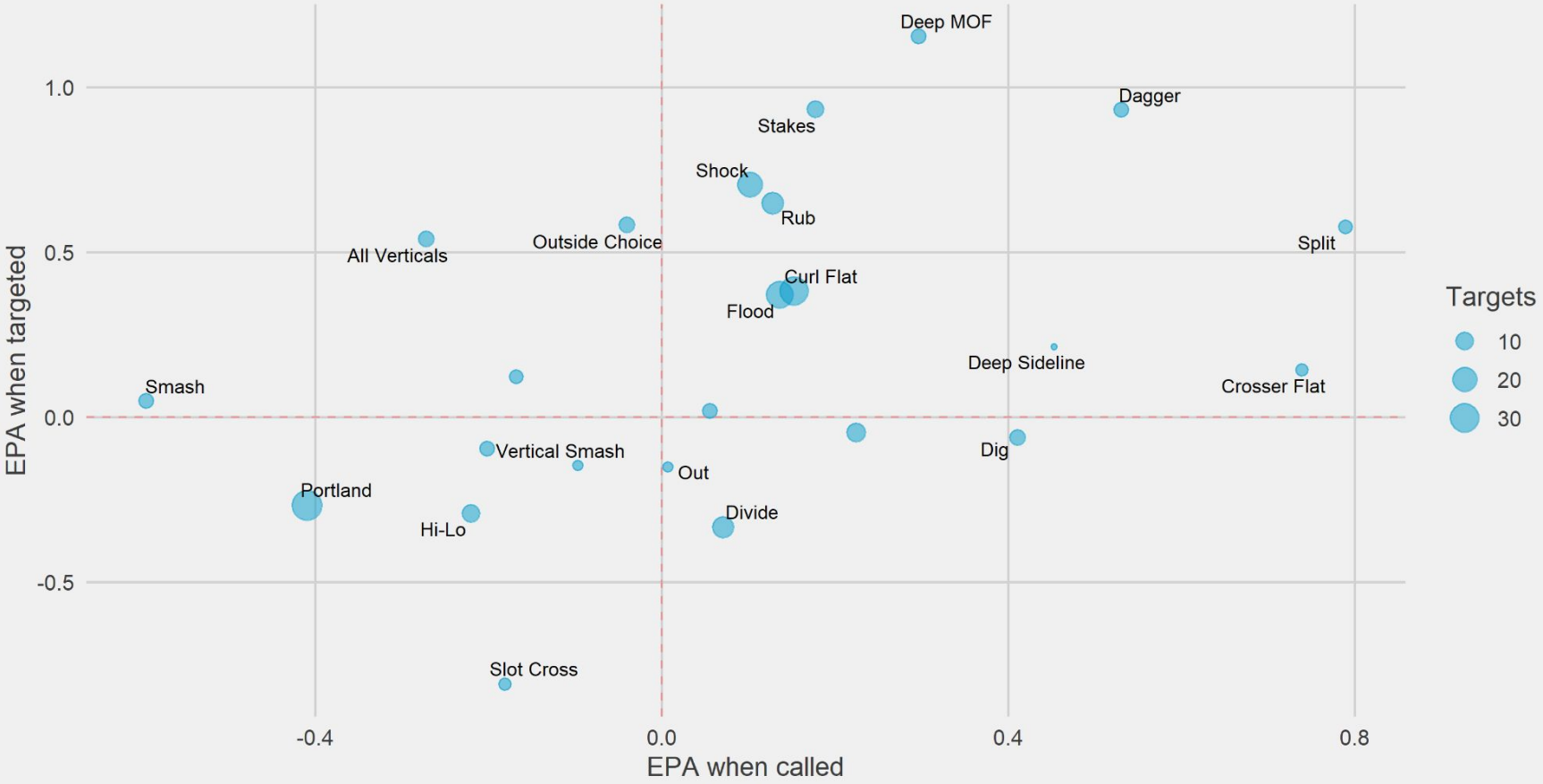
Best Concepts vs Cover 2 Man

- Deep Sideline
- All Verticals
- Comeback
- Crosser Flat
- All Shallow Crossers
- Divide

- A majority of the routes had a negative EPA/play when called
- The routes that had a positive EPA/play when called and targeted were generally longer, developing routes.

Concepts vs Cover 6

Minimum 10 plays against Cover 6



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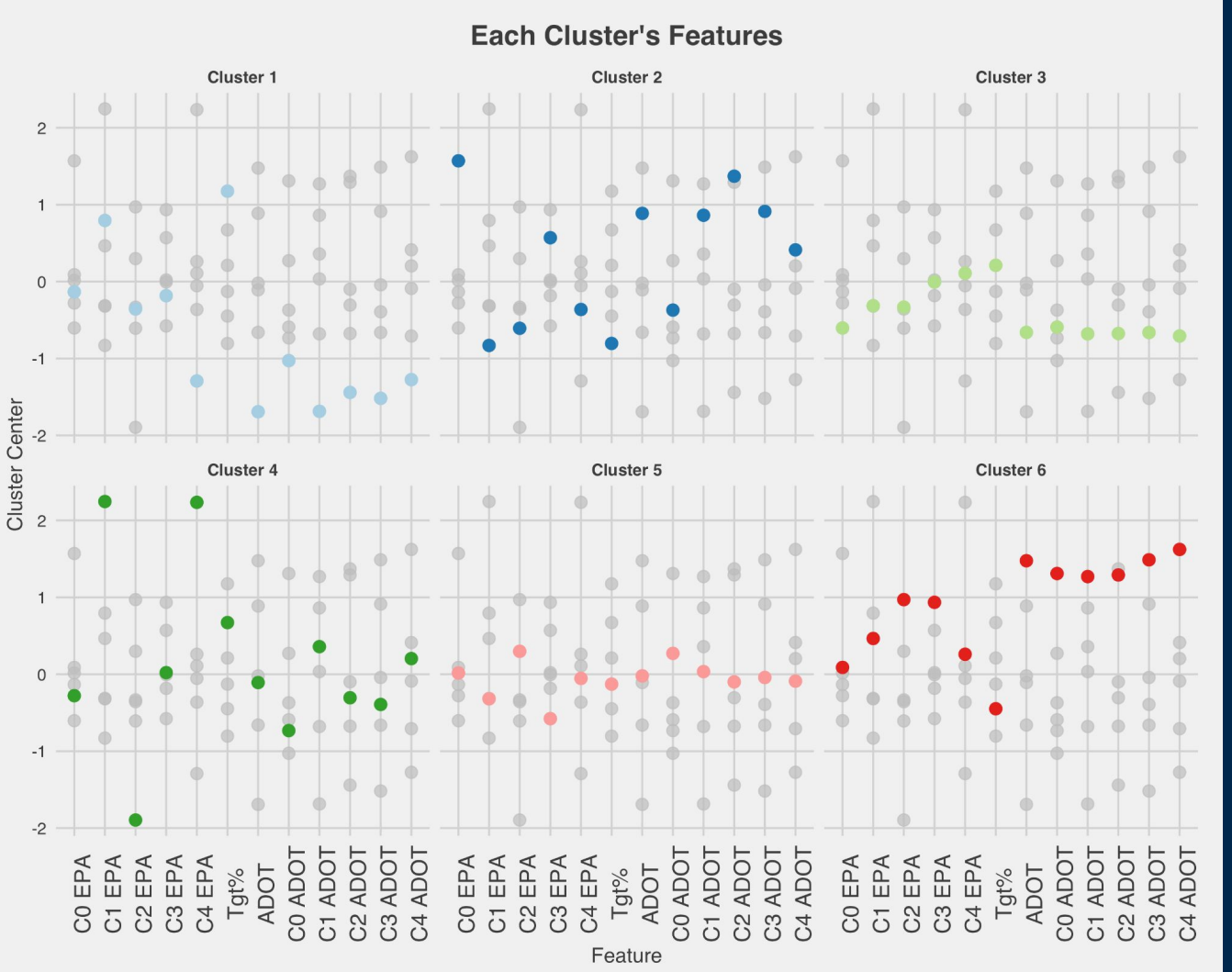
Best Concepts vs Cover 6

- Deep MOF
- Dagger
- Split
- Stakes
- Rub
- Shock

- The issue with this analysis is that none of the route concepts were targeted more than 30 times against Cover 6
- This led to the routes being spread out throughout the graph, unlike some of the other Coverages
- Cover 6 is a combination of Cover 2 and 4, so based on the side of the field the concept is ran, we expect that half-field concepts that perform well against Cover 2 or Cover 4 would perform well.

Route Clustering

- Next we used a K-Means clustering algorithm to group together route concepts with more than 100 plays based on the following features
  - EPA/play Against Cover 0
  - EPA/play Against Cover 1
  - EPA/play Against Cover 2
  - EPA/play Against Cover 3
  - EPA/play Against Cover 4
  - Target Rate
  - Average Depth of Target (aDOT)
  - aDOT Against Cover 0
  - aDOT Against Cover 1
  - aDOT Against Cover 2
  - aDOT Against Cover 3
  - aDOT Against Cover 4


Each Cluster's Features
Cluster 1
Cluster 2
Cluster 3
Cluster 4
Cluster 5
Cluster 6
Cluster Center
2
1
0
-1
-2
C0 EPA
C1 EPA
C2 EPA
C3 EPA
C4 EPA
Tgt%
ADOT
C0 ADOT
C1 ADOT
C2 ADOT
C3 ADOT
C4 ADOT
Feature

Each Cluster Features

- Cluster 1
  - Bad against Cover 4
  - Very low ADOT across all coverages
- Cluster 2
  - Great against Cover 0
  - High ADOT vs Cover 1 & 2
- Cluster 3
  - Bad against Cover 0
  - Bad against Cover 1
- Cluster 4
  - Great against Cover 1
  - Great against Cover 4
- Cluster 5
  - Bad against Cover 3
  - Average vs all other coverages
- Cluster 6
  - Very high ADOT vs all coverages
  - Great against Cover 2 & 3

Route Combinations and their Cluster

ROUTE CONCEPT	CLUSTER
Flat	1
WR Screen	1
MOF Screen	1
Mesh	1
Comeback	2
Deep MOF - Flat	2
Deep Sideline	2
Switch	2
All Curls	3
All Digs	3
All Outs	3
All Shallow Crossers	3
Crosser Flat	3
Hi-Lo	3
Rub	3
Shallow Crosser	3
Stick	3
Cross-7	3
Dig - Flat	4
Overs	4

Table: MFANS SIS Submission

Route Combinations and their Cluster

ROUTE CONCEPT	CLUSTER
Curl	5
Curl Flat	5
Dagger	5
Dig	5
Flood	5
Out	5
Outside Choice	5
Rebel	5
Shock	5
Smash	5
Split	5
Stakes	5
Vertical Smash	5
Portland	5
All Verticals	6
Deep MOF	6
Divide	6
Double Posts	6
Scissors	6
Slot Cross	6
Vertical	6

Table: MFANS SIS Submission

Limitations & Future Analysis

- Only one year of data was provided - the small sample sizes caused problems when trying to analyze Cover 0 & 6 which had low target sizes for most concepts.
- We were unable to categorize about 3k plays, so there is some lost data
- Some concepts had small sample sizes
- For the future, tracking data would be an optimal way to evaluate routes and coverages. It would improve the research being done and more could be done using metrics like receiver separation

Appendix

- Route Categorization
  - Go/Fly, Fade - Back Shoulder, Fade, Hitch & Go, Sluggo, Seam, Out & Up, Chip - Seam = Vertical
  - Slant, Beneath, Drag, Chip - Drag = Shallow Crosser
  - Post, Corner Post, Deep Cross, Stick - Nod = Deep MOF
  - Corner, Post Corner = Deep Sideline
  - Flat - Left, Flat - Right = Flat
  - Jet Sweep Pass, Screen - RB, Screen - Shovel, Screen - Beneath, Screen - Drag = MOF Screen
  - Screen - TE, Screen - Quick, Screen - Tunnel, Quick, Screen - Bubble = Outside Screen

Appendix Continued

- All route ‘x’s = Every receiver on a side runs route ‘x’
- Flood = Outside Vertical, Inside Out
- Smash = Outside Curl, Inside Deep Sideline
- Vertical Smash = Outside Curl, Inside Vertical
- Curl Flat = Outside Curl, Inside Flat or Out
- Crosser Flat = One or Two Outside Shallow Crossers, One or Two Inside Flats or Outs
- Hi-Lo = Dig/Deep MOF with a shallow crosser on the same side
- Rub = two different outward breaking routes on the same side (Deep Sideline/Out/Flat/Whip/Comeback)
- Slot Cross = Outside Dig, Inside Deep MOF

Appendix Continued

- Dagger = Outside Dig/Deep MOF/Shallow Crosser, Inside Vertical
- Stakes = Outside Dig, Inside Out/Whip or Outside Shallow Crosser, Inside Deep Sideline
- Scissors = Outside Dig/Deep MOF, Inside Deep Sideline
- Stick = Outside Out, Inside Curl/Over Ball
- Stick = 1st from sideline Vertical, 2nd and 3rd must have one Curl/Over Ball and one Out/Flat
- Dolphin = 1st from sideline Dig, 2nd Whip, 3rd Vertical
- X = 1st from sideline Dig/Shallow Crosser, 2nd Vertical, 3rd Shallow Crosser
- DL Dig = 1st from sideline Dig, 2nd Dig, 3rd Flat
- Wall = 1st from sideline Vertical, 2nd and 3rd Whip/Out/Flat

Appendix Continued

- Shock = 1st from sideline Curl/Vertical, 2nd Curl/Vertical, 3rd Curl where 1st and 2nd are not the same
- Shock = Outside Vertical/Deep MOF, Inside Curl
- Seattle = 1st from sideline Vertical, 2nd and 3rd Deep MOF
- Divide = Outside Vertical/Comeback, Inside Deep MOF/Shallow Crosser/Dig
- Switch = Outside Deep MOF/Vertical, Inside Wheel
- Inverted Stick = 1st from sideline Curl, 2nd Vertical, 3rd Out
- Split = Outside Out/Deep Sideline, Inside Dig/Shallow Crosser/Deep MOF
- Outside Choice = Outside Curl, Inside Deep MOF/Dig/Shallow Crosser

Appendix Continued

- Rebel = 1st and 2nd Dig, 3rd Vertical/Deep MOF/Deep Sideline
- Mills = Outside Deep MOF, Inside Dig
- Overs = Deep Cross from opposite sides of the field
- Mesh = Drags from opposite sides of the field with a 0/1, 3, or 5 step drop
- Cross-7 = Post/Deep Cross and Deep Sideline from opposite sides
- Y-Cross = Dig and Shallow Crosser from opposite sides
- Portland = Post and Deep Cross from opposite sides