Performance Testing and Player Safety on Athletic Fields

C

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Athlete Injuries

- Injuries will always occur
- Focus is primarily placed on safety equipment





Athlete Injuries

• Field playability is also linked to player safety



Sports Field Management

- Athletic fields often blamed first for poor athletic performances
- Monetary inputs for field management are insufficient and usually an afterthought



Artificial Turf vs. Natural Grass Sports Fields

- Neither are management free
- Both exhibit field variability
- Injuries occur on either surface
- Focus needs to be on player safety and field playability



Performance Testing

- Gather information about your field/facility
- Use everything from low to high tech
- Due diligence should outweigh legal concerns



Performance Testing

- Player-Surface Interactions:
 - Compaction
 - Hardness
 - -Traction
 - Uniformity
 - -Wear Tolerance



www.sfgate.com/sports



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Hand-held Sensors





Soil Moisture Meter

- TDR Probe
- Measures soil moisture from a depth of 1.5 to 8 inches
- Recorded as % volumetric water content (%VWC)
- GPS compatible



Soil Compaction

- Penetrometer
- Determines soil compaction (to a depth of 18 inches) and potential water infiltration
- Recorded in pounds per square inch (PSI)



Surface Hardness

- Clegg Impact Tester
- Determines surface hardness in the upper 2 inches of the soil profile
- Recorded in gravities (G-max)



Shear Strength

- Shear Vane
- Measures rotational strength of the turfgrass (Nm)
- Influences the ability of athletes to grip the turf and make cuts



Plant Health/Turf Color

- NDVI Chlorophyll Meter
- Readings are reported on a scale of -1 to 1
- The NDVI value is a measure of leaf area index and green biomass
- Color Meter
- Readings reported as turf color on a scale of 1 to 9



Mobile Sensors



Mobile Sensors



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Handheld versus Mobile Data Acquisitions for Spatial Analysis of Natural Turfgrass Sports Fields

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Additional index words. kriging, normalized difference vegetative index, penetration resistance, precision turfgrass management, variability, volumetric water content

Mobile data acquisition devices equipped with GPS are pertinent for rapid sampling of spatial data in agriculture (Adamchuk et al., 2004; Corwin and Lesch, 2005; Rhoades et al., 1999); however, few mobile devices are currently available for use in turfgrass. Developed in 2005, the Toro Precision Sense 6000 (PS6000) was the first and only mobile multisensor sampling device engineered for turfgrass sites (The Toro Company, Bloomington, MN). The PS6000 was engineered for simultaneous rapid sampling of soil moisture (VWC; %), soil compaction (penetration resistance; MPa), and plant performance (NDVI; unit less with best = 1.0) of complex turfgrass sites. This device has an onboard GPS unit that identifies the latitudinal and

- Strong correlations for soil moisture and NDVI
- Moderate correlation for soil compaction
 - Mobile sensors insert penetrometer rods at a uniform speed = more accuracy

Field Measurements



Sample points

Spatial Maps





Variability

 Occurs when a measured quantity is different across and between locations



Soil Moisture

Causes of Variability

- Natural Occurrence
- Field use
 - Sport specific
 - Frequency
- Cultural practices
 - Irrigation
 - Aerification
 - Etc.







Measurable Variables

- Soil Moisture
- Soil Compaction
- Surface Hardness
- Turfgrass Health
- Shear Strength
- Turfgrass Thatch



Links Between Variables

Case Study: Oconee County H.S., GA

- Measured Variables
 - Soil moisture (VWC)
 - Soil compaction (PR)
 - Turf quality (NDVI)
 - Surface hardness (Gmax)
 - Thatch depth
 - Root mass
 - 0-2 inch depth
 - 2-5 inch depth





VWC→ ♥	-0.71	-0.82	0.49	-0.11	-0.23	0.02	-0.13
	↑ ←Comp	0.73	-0.49	0.04	0.13	-0.08	0.03
		Hard	-0.58	0.05	0.21	-0.03	0.12
			NDVI	0.06	-0.10	0.12	0.01
				Thatch	0.12	0.02	0.06
					Roots (upper)	0.53	0.86
						Roots (lower)	0.87
							Roots (total)

Spatial Variability



Measurable Variables

- Soil Moisture
- Soil Compaction
- Surface Hardness
- Turfgrass Health
- Shear Strength
- Turfgrass Thatch

 Root Length and Mass

Influence of Soil Moisture

Soil Compaction Surface Hardness Thatch Depth



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Evaluation of Several Sampling Procedures for Spatial Analysis of Natural Turfgrass Sports Field Properties

Reference

Straw, C. M., Henry, G. M., Love, K., Carrow, R. N., and Cline, V., "Evaluation of Several Sampling Procedures for Spatial Analysis of Natural Turfgrass Sports Field Properties," *Journal of Testing and Evaluation*, Vol. 46, No. 2, 2018, pp. 714–729, https://doi.org/10.1520/JTE20160467. ISSN 0090-3973

How many samples are needed to accurately depict field performance?

Historical Testing Procedures

Testing Natural Turf Sports Surfaces: The Value of Performance Quality Standards



Bartlett et al., 2009

ASTM F1936 – Test Procedure



10 Clegg Readings – Surface Hardness

Accuracy of Sample Size

450 Samples	115 Samples	36 Samples		
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Spatiotemporal variation of site-specific management units on natural turfgrass sports fields during dry down

Chase M. Straw¹ · Gerald M. Henry¹

Influence of sampling time on data collection

Dry Down Following Irrigation Events

- 5 day soil dry down
- 120 samples
 - Soil moisture (VWC)
 - Soil compaction (PR)
 - Turf quality (NDVI)
 - Surface hardness (Gmax)
 - Traction





Influence of Sampling Time

	VWC (%)			Penetration Resistance (lbs. of force)			NDVI (1 is best)					
	Min	<u>Max</u>	<u>Mean</u>	<u>SD</u>	Min	<u>Max</u>	Mean	<u>SD</u>	Min	<u>Max</u>	Mean	<u>SD</u>
Day 1	6.9	32.3	22.9	3.7	62	449	155	45	0.27	0.77	0.64	0.09
Day 3	4.2	27.8	17.3	4.7	60	354	178	50	0.34	0.76	0.64	0.07
Day 5	3.1	28.9	15.1	5.1	66	366	194	47	0.37	0.78	0.66	0.07
Change day 1 to 5 = -34.1%			+25.2%				+3.1%					
K								ļ	6			
- 34%			+	25%	6			+ 3	%			



Day 1

Day 5

Influence of Sampling Time

	Surface Hardness (Gmax)				Shear Strength (Nm)				
	Min	<u>Max</u>	Mean	<u>SD</u>	Min	<u>Max</u>	Mean	<u>SD</u>	
Day 1	63	118	80	9	8.5	25.5	17.9	3.5	
Day 5	72	130	92	10	<mark>6.</mark> 0	24.5	15.8	3.4	
Change day 1 to 5 = +15.0%					- 11.7%				
							<u>k</u>		
	+ 15 %					- 12	%		

Rainfall versus Irrigation Influences Penetration Resistance and Surface Hardness on a Recreational Sports Field

Chase M. Straw,* William J. Bowling, and Gerald M. Henry

Influence of Soil Moisture on Data Collection

Irrigation System Efficiency





Malfunctioning Irrigation Head

How does variability impact player injuries?





European Journal of Sport Science

ISSN: 1746-1391 (Print) 1536-7290 (Online) Journal homepage: http://www.tandfonline.com/loi/tejs20

Does variability within natural turfgrass sports fields influence ground-derived injuries?

Chase M. Straw, Christine O. Samson, Gerald M. Henry & Cathleen N. Brown

- Collaboration with UGA Biomechanics Lab and Rec Sports
- Men's and Women's Rugby, Ultimate Frisbee, Soccer, and Lacrosse

Participation

<u>Year 1</u>

Rugby (fall and spring) Male (n = 12)Female (n = 13)

Ultimate Frisbee (spring only) Male (*n* = 8) Female (*n* = 7)

Total = 40

Ultimate Frisbee (fall and spring) Male (*n* = 14) Female (*n* = 4)

Year 2

Rugby (spring only) Female (*n* = 12)

Lacrosse (spring only) Female (*n* = 16)

Total = 46

Baseline Screens

- Beginning of season
- Self-report previous sports-related injuries
- Identify outdoor footwear
- Assess movement abilities
 - Functional Movement Screen
 - -3D motion capture



Functional Movement Screen





Injury Surveillance



Did you suffer an injury during practice or competition last week?

An injury is defined as a physical complaint (pain, discomfort, etc.) that resulted from participating in your team's practice or competition, whether you sought medical treatment for it or not.



Distributed weekly to determine:

- Team activity
- Injury occurrence
 - Injury specifics
 - Treatment sought
 - Return to play abilities
 - Previous similar injuries

Field Measurements

Weekly:Soil moistureTurf health (NDVI)

Bi-weekly:

- Surface hardness
- Rotational traction



Hot Spot Analysis



Club Field

Rec Field



Field Measurements

Weekly:

- Soil moisture
- Turf quality (NDVI)

Bi-weekly:

- Surface hardness
- Shear strength

Data were averaged by month



Injuries (Ground-derived)

Team	Injuries
Men's Rugby	2
Women's Rugby	9
Men's Ultimate	7
Women's Ultimate	4
Women's Lacrosse	1
Total	23

Injuries (Ground-derived)

Body Region	Injuries	% of Total
Head/neck/face	2	9
Upper limb	4	17
Lower limb	17	74
Total	23	100

Injuries in Hot/Cold Spots

1.Soil moisture (15/19 injuries; 79%)

2. Turfgrass quality (16/21 injuries; 76%)

3. Surface hardness and turfgrass shear strength (13/23 injuries; 57%)

Edge Effect





Edge Effect

- Turfgrass quality (11/15 injuries)
- Soil moisture (14/16 injuries)
- Surface hardness (9/13 injuries)







Managing Variability

- Can't be eliminated
- Proper cultural practices

 Site specific management
- Increasing rooting depth/mass
 Increasing rooting depth/mass





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