Supplementary Materials

Google4Habitat – a novel method for remote sensing-based habitat classification using Google Earth Engine

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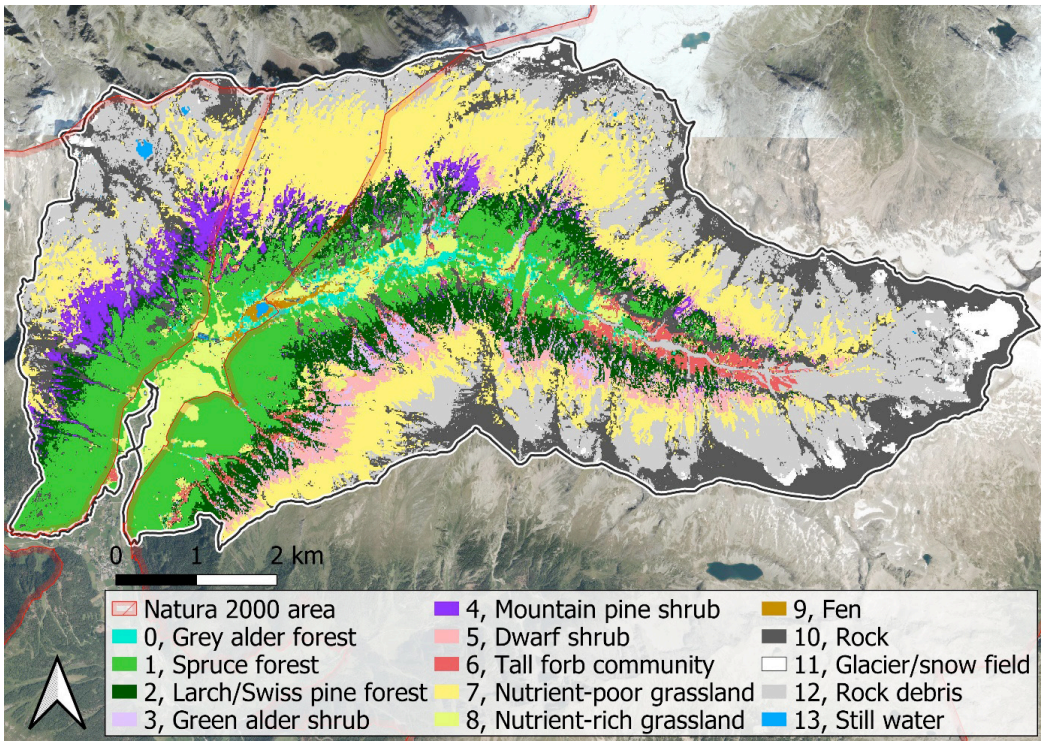
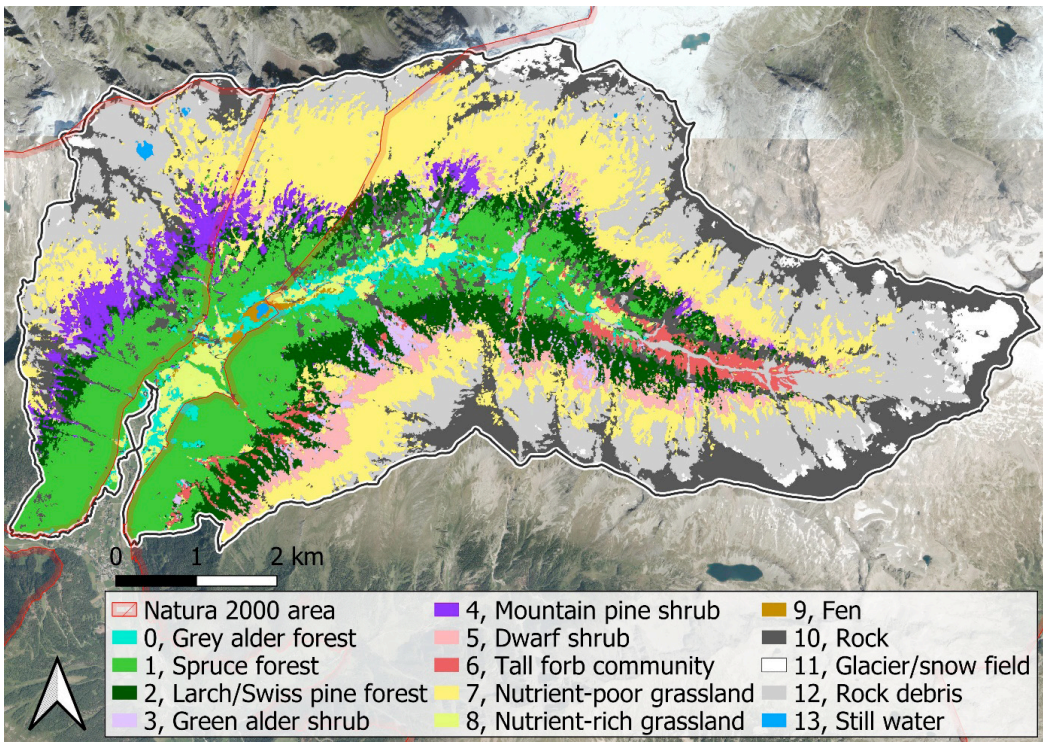


Suppl. Fig. 1

Supplementary Figure 1: Map 1a2, based on Sentinel-2 data, LiDAR data, and corrected reference points for 2022. Source: own figure

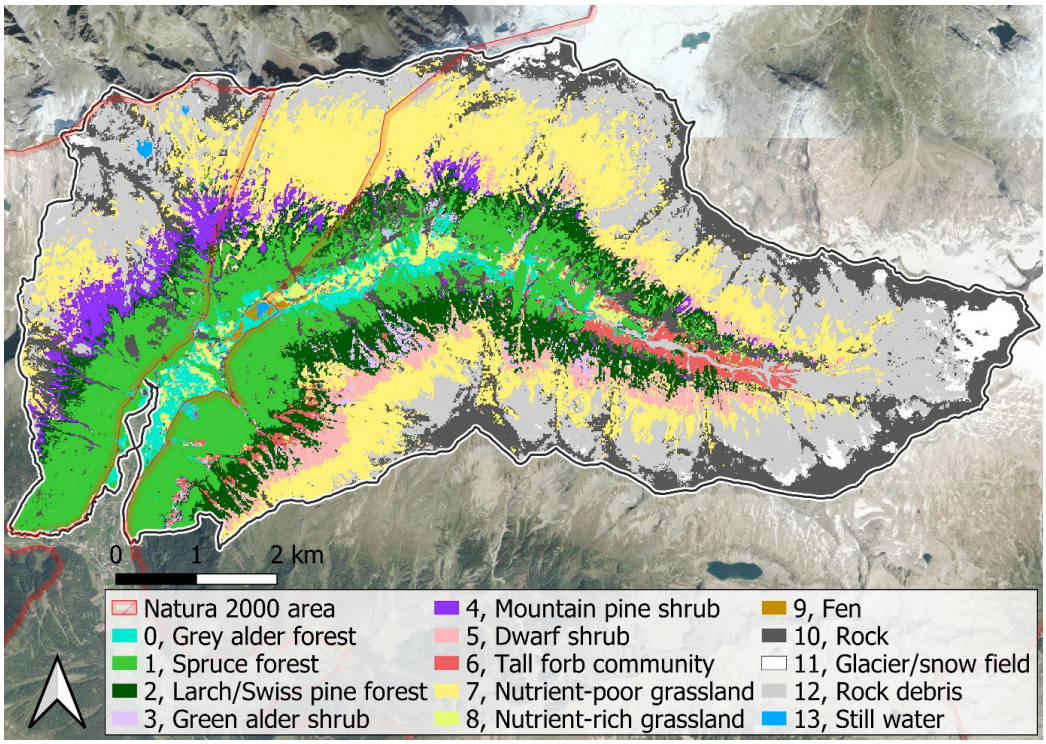
Ergänzende Abbildung 1: *Karte 1a2, basierend auf Sentinel-2 Daten, LiDAR Daten und korrigierten Referenzpunkten für 2022. Quelle: eigene Abbildung*



Suppl. Fig. 2

Supplementary Figure 2: Map 1b, segmentation map of Map 1a1. Source: own figure

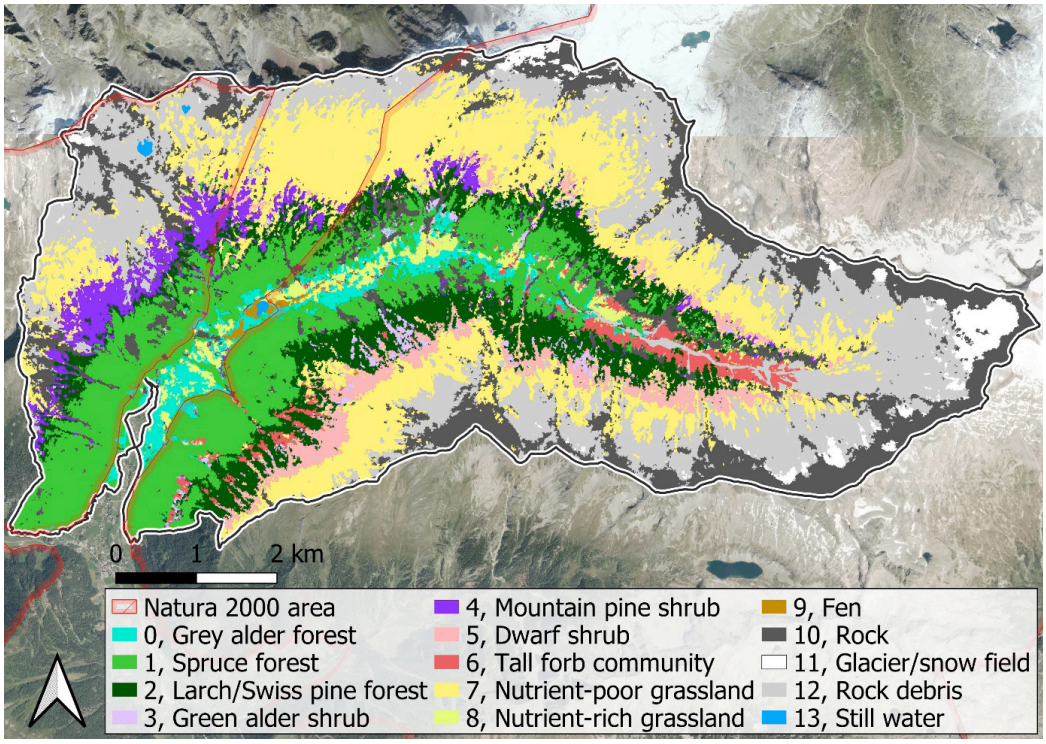
Ergänzende Abbildung 2: *Karte 1b, Segmentierungskarte von Karte 1a1. Quelle: eigene Abbildung*



Suppl. Fig. 3

Supplementary Figure 3: Map 2a, based on Sentinel-2 data and reference points for 2022. Source: own figure

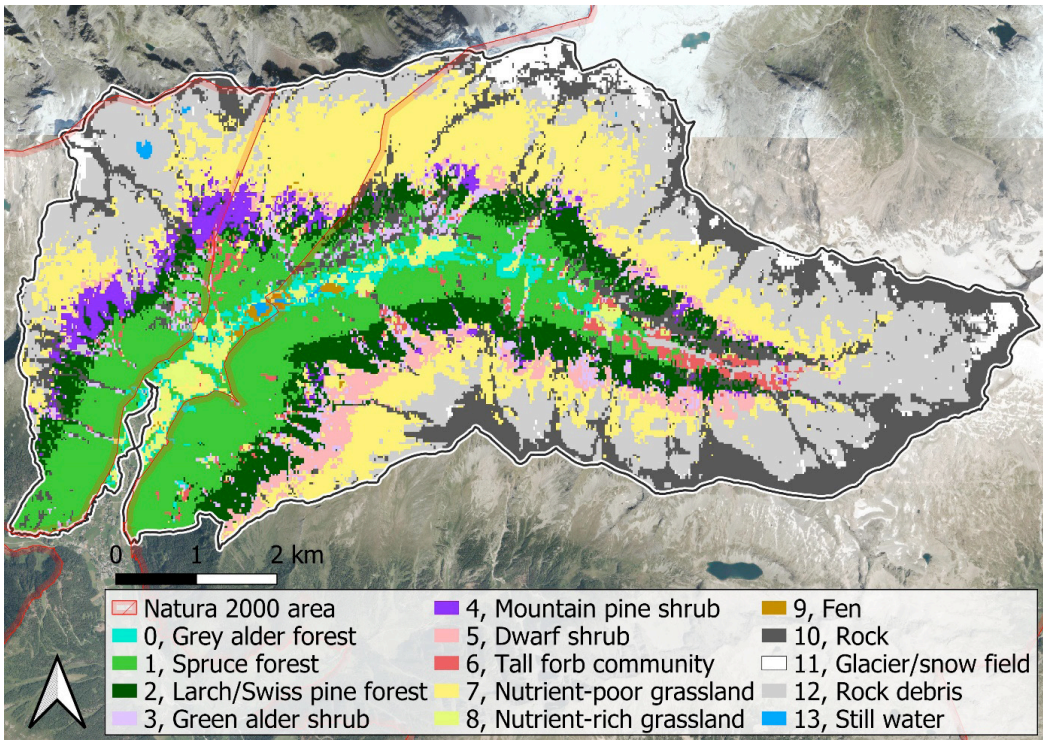
Ergänzende Abbildung 3: *Karte 2a, basierend auf Sentinel-2 Daten und Referenzpunkten für 2022. Quelle: eigene Abbildung*



Suppl. Fig. 4

Supplementary Figure 4: Map 2b, segmentation map of Map 2a. Source: own figure

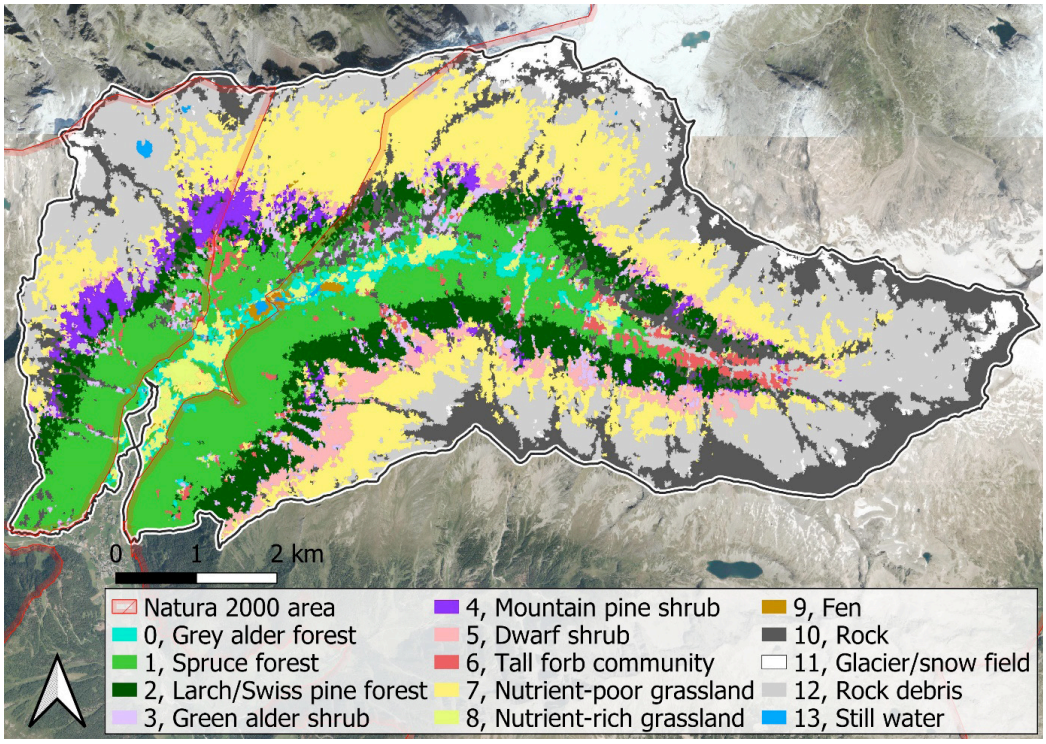
Ergänzende Abbildung 4: *Karte 2b, Segmentierungskarte von Karte 2a. Quelle: eigene Abbildung*



Suppl. Fig. 5

Supplementary Figure 5: Map 3a, based on Landsat data, LiDAR data, and reference points for 2002. Source: own figure

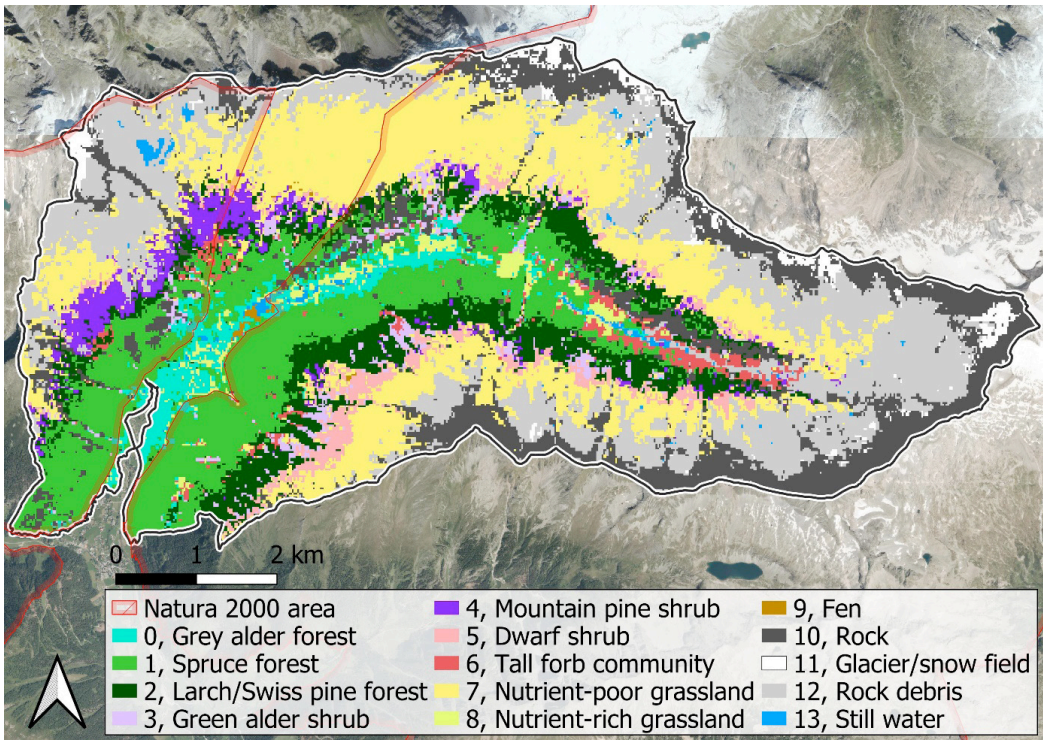
Ergänzende Abbildung 5: *Karte 3a, basierend auf Landsat Daten, LiDAR Daten und Referenzpunkten für 2002. Quelle: eigene Abbildung*



Suppl. Fig. 6

Supplementary Figure 6: Map 3b, segmentation map of Map 3a. Source: own figure

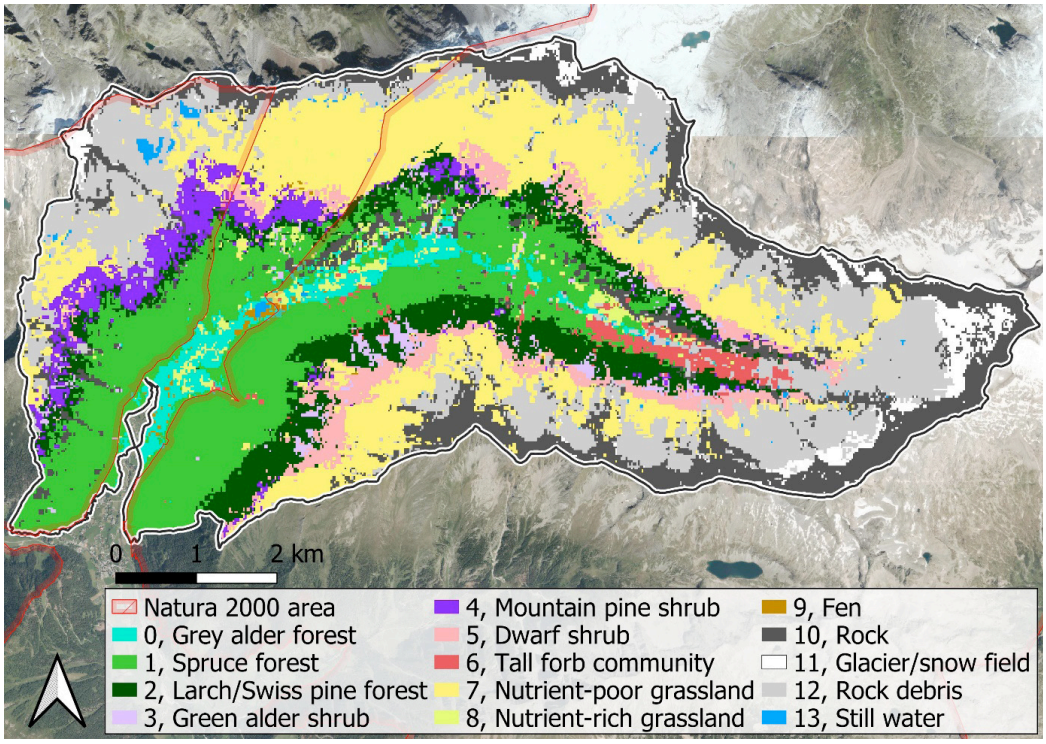
Ergänzende Abbildung 6: *Karte 3b, Segmentierungskarte von Karte 3a. Quelle: eigene Abbildung*



Suppl. Fig. 7

Supplementary Figure 7: Map 4, classification map based on Landsat data (without LiDAR) and reference points for 2022 (terrain map).
Source: own figure

Ergänzende Abbildung 7: *Karte 4, Klassifikationskarte basierend auf Landsat Daten (ohne LiDAR) und Referenzpunkten für 2022 (Geländemodell).*
Quelle: eigene Abbildung



Suppl. Fig. 8

Supplementary Figure 8: Map 5a, classification map based on Landsat data (without LiDAR) and reference points for 2002, trained on Landsat-5 data from 1992.
Source: own figure

Ergänzende Abbildung 8: *Karte 5a, Klassifikationskarte basierend auf Landsat Daten (ohne LiDAR) und Referenzpunkten für 2002, trainiert auf Landsat-5 Daten von 1992.*
Quelle: eigene Abbildung

Suppl. Tab. 1

	RS model	Grey alder forest	Spruce forest	Larch/Swiss pine forest	Green alder shrub	Mountain pine shrub	Dwarf shrub	Tall forb community	Nutrient-poor grassland	Nutrient-rich grassland	Fen	Rock	Glacier/snow field	Rock debris	Still water	Total	*Producer's accuracy*
Field reference		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**		
Grey alder forest	**0**	**69**	27	0	0	0	0	0	0	4	0	0	0	0	0	100	*0.69*
Spruce forest	**1**	1	**89**	9	0	1	0	0	0	0	0	0	0	0	0	100	*0.89*
Larch/Swiss pine forest	**2**	0	15	**77**	7	0	0	0	0	2	0	0	0	0	0	100	*0.77*
Green alder shrub	**3**	0	7	22	**63**	0	0	4	0	4	0	0	0	0	0	100	*0.63*
Mountain pine shrub	**4**	0	0	7	0	**77**	3	0	13	0	0	0	0	0	0	100	*0.77*
Dwarf shrub	**5**	0	0	0	0	3	**53**	0	45	0	0	0	0	0	0	100	*0.53*
Tall forb community	**6**	0	0	0	4	0	4	**83**	0	9	0	0	0	0	0	100	*0.83*
Nutrient-poor grassland	**7**	0	0	0	0	0	8	0	**87**	2	0	2	0	2	0	100	*0.87*
Nutrient-rich grassland	**8**	10	0	0	0	3	0	3	9	**74**	0	0	0	0	0	100	*0.74*
Fen	**9**	0	0	0	0	0	0	0	64	0	**36**	0	0	0	0	100	*0.36*
Rock	**10**	0	1	1	0	1	0	0	1	0	0	**87**	0	8	0	100	*0.87*
Glacier/snow field	**11**	0	0	0	0	0	0	0	0	0	0	13	**58**	26	3	100	*0.58*
Rock debris	**12**	0	0	0	0	0	0	0	4	0	0	12	4	**80**	0	100	*0.80*
Still water	**13**	0	0	0	0	0	0	0	0	0	0	0	0	0	**100**	100	*1.00*

Supplementary Table 1: Confusion matrix for Map 1a2, including producer's accuracy values

Ergänzende Tabelle 1: *Fehlermatrix für Karte 1a2 mit producer's accuracy Werten*

Suppl. Tab. 2

	RS model	Grey alder forest	Spruce forest	Larch/Swiss pine forest	Green alder shrub	Mountain pine shrub	Dwarf shrub	Tall forb community	Nutrient-poor grassland	Nutrient-rich grassland	Fen	Rock	Glacier/snow field	Rock debris	Still water	Total	*Producer's accuracy*
Field reference		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**		
Grey alder forest	**0**	**92**	8	0	0	0	0	0	0	0	0	0	0	0	0	100	*0.92*
Spruce forest	**1**	1	**92**	5	0	1	0	0	0	0	0	2	0	0	0	100	*0.92*
Larch/Swiss pine forest	**2**	2	12	**80**	0	5	0	0	0	2	0	0	0	0	0	100	*0.80*
Green alder shrub	**3**	7	0	30	**30**	4	11	15	4	0	0	0	0	0	0	100	*0.30*
Mountain pine shrub	**4**	0	0	7	0	**90**	0	0	3	0	0	0	0	0	0	100	*0.90*
Dwarf shrub	**5**	0	0	3	0	3	**53**	3	40	0	0	0	0	0	0	100	*0.53*
Tall forb community	**6**	0	0	0	10	0	14	**67**	0	10	0	0	0	0	0	100	*0.67*
Nutrient-poor grassland	**7**	0	0	0	0	0	3	1	**94**	2	0	0	0	1	0	100	*0.94*
Nutrient-rich grassland	**8**	4	0	8	0	4	8	16	24	**36**	0	0	0	0	0	100	*0.36*
Fen	**9**	7	0	0	0	7	0	0	7	0	**79**	0	0	0	0	100	*0.79*
Rock	**10**	0	1	1	0	1	0	0	5	0	0	**68**	5	18	0	100	*0.68*
Glacier/snow field	**11**	0	0	0	0	0	0	0	0	0	0	16	**68**	16	0	100	*0.68*
Rock debris	**12**	0	0	0	0	0	0	0	3	0	0	11	5	**81**	0	100	*0.81*
Still water	**13**	6	0	0	0	0	0	0	0	0	6	0	0	0	**89**	100	*0.89*

Supplementary Table 2: Confusion matrix for Map 2a, including the producer's accuracy values

Ergänzende Tabelle 2: *Fehlermatrix für Karte 2a mit producer's accuracy Werten*

Suppl. Tab. 3

RS model	Grey alder forest	Spruce forest	Larch/Swiss pine forest	Green alder shrub	Mountain pine shrub	Dwarf shrub	Tall forb community	Nutrient-poor grassland	Nutrient-rich grassland	Fen	Rock	Glacier/snow field	Rock debris	Still water	Total	*Producer's accuracy*
Field reference	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**		
Grey alder forest	**0**	**76**	20	0	4	0	0	0	0	0	0	0	0	0	0	100	*0.76*
Spruce forest	**1**	0	**91**	9	0	0	0	0	0	0	0	0	0	0	0	100	*0.91*
Larch/Swiss pine forest	**2**	0	12	**83**	3	0	0	0	0	0	0	2	0	0	0	100	*0.83*
Green alder shrub	**3**	7	4	4	**56**	7	7	4	4	4	0	4	0	0	0	100	*0.56*
Mountain pine shrub	**4**	0	0	17	3	**63**	10	0	7	0	0	0	0	0	0	100	*0.63*
Dwarf shrub	**5**	0	0	0	0	5	**63**	0	28	3	3	0	0	0	0	100	*0.63*
Tall forb community	**6**	0	0	0	10	0	10	**57**	5	19	0	0	0	0	0	100	*0.57*
Nutrient-poor grassland	**7**	0	0	0	1	1	9	0	**80**	1	1	3	0	5	0	100	*0.80*
Nutrient-rich grassland	**8**	0	0	4	4	0	8	24	36	**12**	8	4	0	0	0	100	*0.12*
Fen	**9**	0	0	0	0	0	0	0	14	0	**86**	0	0	0	0	100	*0.86*
Rock	**10**	0	1	1	0	0	0	0	8	0	0	**68**	5	16	0	100	*0.68*
Glacier/snow field	**11**	0	0	0	0	0	0	0	0	0	0	6	**35**	55	3	100	*0.35*
Rock debris	**12**	0	0	0	0	0	0	0	5	0	0	11	4	**80**	0	100	*0.80*
Still water	**13**	6	0	0	0	0	0	0	0	0	6	0	0	0	**89**	100	*0.89*

Supplementary Table 3: Confusion matrix for Map 3a, including the producer's accuracy values

Ergänzende Tabelle 3: *Fehlermatrix für Karte 3a mit producer's accuracy Werten*

Suppl. Tab. 4

<- Classification Sentinel+LIDAR (1a1)	Grey alder forest	Spruce forest	Larch/Swiss pine forest	Green alder shrub	Mountain pine shrub	Dwarf shrub	Tall forb community	Nutrient-poor grassland	Nutrient-rich grassland	Fen	Rock	Glacier/snow field	Rock debris	Still water	Total	Producer's accuracy
Classification Landsat+LIDAR (3a) ->	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**		
Grey alder forest	**0**	**55**	17	1	1	0	0	1	0	14	3	6	0	1	0	100	*0.55*
Spruce forest	**1**	5	**79**	7	1	1	0	1	0	1	0	4	0	0	0	100	*0.79*
Larch/Swiss pine forest	**2**	0	11	**63**	8	6	3	2	4	1	0	2	0	0	0	100	*0.63*
Green alder shrub	**3**	4	13	21	**24**	6	8	6	9	4	0	5	0	0	0	100	*0.24*
Mountain pine shrub	**4**	0	1	6	4	**62**	8	1	13	0	0	3	0	2	0	100	*0.62*
Dwarf shrub	**5**	0	0	3	6	5	**51**	0	31	0	0	0	0	1	0	100	*0.51*
Tall forb community	**6**	3	7	7	7	6	1	**42**	5	10	0	8	0	4	0	100	*0.42*
Nutrient-poor grassland	**7**	0	0	1	1	2	3	0	**81**	1	0	4	0	7	0	100	*0.81*
Nutrient-rich grassland	**8**	10	2	3	3	2	1	8	5	**60**	4	5	0	0	0	100	*0.60*
Fen	**9**	12	0	0	0	1	1	0	8	28	**49**	0	0	0	1	100	*0.49*
Rock	**10**	1	2	3	0	1	0	1	6	0	0	**74**	4	8	0	100	*0.74*
Glacier/snow field	**11**	1	0	0	0	0	0	0	1	0	0	22	**49**	27	0	100	*0.49*
Rock debris	**12**	0	0	0	0	0	0	1	8	0	0	7	3	**81**	0	100	*0.81*
Still water	**13**	1	0	0	0	0	0	0	0	13	16	1	0	7	**62**	100	*0.62*

Supplementary Table 4: Confusion matrix for the intersection of Maps 1a1 and 3a, including the producer's accuracy values

Ergänzende Tabelle 4: *Fehlermatrix für die Verschneidung von Karten 1a1 und 3a mit producer's accuracy Werten*

Suppl. Tab. 5

Classification (a)	Grey alder forest	Spruce forest	Larch/Swiss pine forest	Green alder shrub	Mountain pine shrub	Dwarf shrub	Tall forb community	Nutrient-poor grassland	Nutrient-rich grassland	Fen	Rock	Glacier/snow field	Rock debris	Still water	Total	Producer's accuracy
Segmentation (b)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**		
Grey alder forest **0**	74.2	12.8	0.5	0.5	0.1	0.0	1.0	0.1	8.0	0.9	1.7	0.0	0.1	0.0	100	*0.74*
Spruce forest **1**	1.4	92.8	3.1	0.2	0.2	0.0	0.2	0.1	0.4	0.0	1.6	0.0	0.0	0.0	100	*0.93*
Larch/Swiss pine forest **2**	0.2	5.7	80.0	3.0	2.9	1.9	1.5	2.4	0.4	0.0	2.0	0.0	0.0	0.0	100	*0.80*
Green alder shrub **3**	0.7	3.4	24.2	48.0	3.2	8.1	3.3	5.9	1.2	0.0	2.0	0.0	0.0	0.0	100	*0.48*
Mountain pine shrub **4**	0.1	1.9	9.3	1.2	75.9	1.3	0.2	6.3	0.5	0.0	2.3	0.0	0.9	0.0	100	*0.76*
Dwarf shrub **5**	0.0	0.0	5.8	3.8	2.3	75.1	0.5	12.0	0.1	0.0	0.3	0.0	0.1	0.0	100	*0.75*
Tall forb community **6**	1.7	2.4	8.8	3.3	0.2	0.5	73.5	1.8	3.0	0.0	2.2	0.0	2.4	0.0	100	*0.74*
Nutrient-poor grassland **7**	0.0	0.0	1.1	0.4	0.8	1.6	0.2	89.6	0.2	0.0	2.1	0.0	3.9	0.0	100	*0.90*
Nutrient-rich grassland **8**	7.5	4.0	2.9	1.2	0.5	0.1	2.2	1.6	77.0	1.0	1.9	0.0	0.1	0.0	100	*0.77*
Fen **9**	10.0	2.1	0.2	0.0	0.9	0.5	0.2	2.6	15.3	64.5	2.8	0.0	0.1	0.7	100	*0.65*
Rock **10**	0.3	2.2	1.2	0.1	0.6	0.1	0.3	3.5	0.3	0.1	84.3	1.2	5.9	0.0	100	*0.84*
Glacier/snow field **11**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6	85.9	6.5	0.0	100	*0.86*
Rock debris **12**	0.0	0.0	0.0	0.0	0.1	0.0	0.2	4.0	0.0	0.0	3.6	0.6	91.5	0.0	100	*0.92*
Still water **13**	0.8	0.1	0.0	0.0	0.0	0.0	0.2	0.3	2.8	1.9	3.0	0.5	8.3	81.9	100	*0.82*

Supplementary Table 5: Confusion matrix of the intersection of Map 1a1 (classification) and Map 1b (segmentation), including the producer's accuracy values

Ergänzende Tabelle 5: *Fehlermatrix für die Verschneidung von Karte 1a1 (Klassifikation) und Karte 1b (Segmentation) mit producer's accuracy Werten*

Suppl. Tab. 6

RS model	Grey alder forest	Spruce forest	Larch/Swiss pine forest	Green alder shrub	Mountain pine shrub	Dwarf shrub	Tall forb community	Nutrient-poor grassland	Nutrient-rich grassland	Fen	Rock	Glacier/snow field	Rock debris	Still water	Total	Producer´s accuracy
Habitat type	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**		
Grey alder forest **0**	**68**	16	0	0	0	0	0	0	8	8	0	0	0	0	100	*0.68*
Spruce forest **1**	3	**86**	10	1	0	0	0	0	0	0	0	0	0	0	100	*0.86*
Larch/Swiss pine forest **2**	0	12	**57**	8	15	3	2	2	2	0	0	0	0	0	100	*0.57*
Green alder shrub **3**	0	4	22	**22**	0	15	4	7	7	0	7	0	7	4	100	*0.22*
Mountain pine shrub **4**	0	10	20	0	**43**	10	0	17	0	0	0	0	0	0	100	*0.43*
Dwarf shrub **5**	0	0	15	3	3	**38**	0	33	0	5	0	0	5	0	100	*0.38*
Tall forb community **6**	5	10	0	5	0	0	**71**	5	5	0	0	0	0	0	100	*0.71*
Nutrient-poor grassland **7**	0	0	2	0	2	4	0	**85**	0	1	1	1	5	0	100	*0.85*
Nutrient-rich grassland **8**	28	4	16	0	0	8	8	24	**12**	0	0	0	0	0	100	*0.12*
Fen **9**	14	0	0	0	0	0	0	21	0	**64**	0	0	0	0	100	*0.64*
Rock **10**	1	0	0	0	0	1	0	9	0	0	**72**	3	14	0	100	*0.72*
Glacier/snow field **11**	0	0	0	0	0	0	0	0	0	0	26	**39**	35	0	100	*0.39*
Rock debris **12**	1	0	0	0	0	0	3	4	0	0	15	7	**71**	0	100	*0.71*
Still water **13**	6	0	0	0	0	0	0	0	0	0	0	0	0	**94**	100	*0.94*

Supplementary Table 6: Confusion matrix for Map 5a, including the producer's accuracy values

Ergänzende Tabelle 6: *Fehlermatrix für Karte 5a mit producer's accuracy Werten*

Suppl. Tab. 7

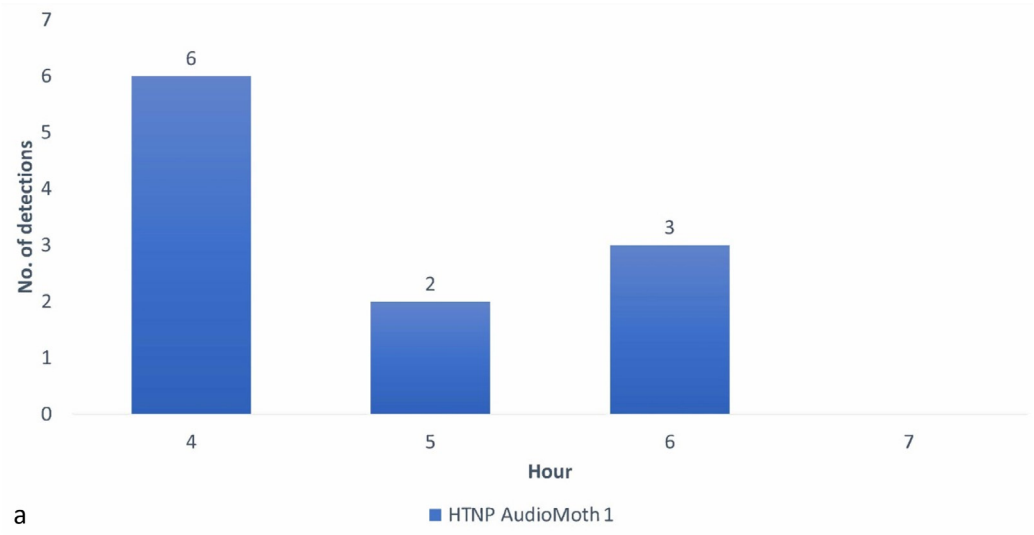
	RS model	Grey alder forest	Spruce forest	Larch/Swiss pine forest	Green alder shrub	Mountain pine shrub	Dwarf shrub	Tall forb community	Nutrient-poor grassland	Nutrient-rich grassland	Fen	Rock	Glacier/snow field	Rock debris	Still water	Total	*Producer's accuracy*
Field reference		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**		
Grey alder forest	**0**	**80**	12	0	4	0	0	4	0	0	0	0	0	0	0	100	*0.80*
Spruce forest	**1**	4	**85**	9	0	0	0	0	0	0	0	2	0	0	0	100	*0.85*
Larch/Swiss pine forest	**2**	2	10	**80**	3	2	0	0	0	0	0	3	0	0	0	100	*0.80*
Green alder shrub	**3**	4	7	7	**52**	0	7	0	7	7	0	4	0	4	0	100	*0.52*
Mountain pine shrub	**4**	0	0	13	10	**63**	3	0	10	0	0	0	0	0	0	100	*0.63*
Dwarf shrub	**5**	0	0	0	0	0	**55**	0	38	3	3	0	0	3	0	100	*0.55*
Tall forb community	**6**	0	0	0	5	0	10	**76**	0	10	0	0	0	0	0	100	*0.76*
Nutrient-poor grassland	**7**	0	0	0	1	0	9	0	**82**	1	1	2	0	6	0	100	*0.82*
Nutrient-rich grassland	**8**	0	0	4	0	0	8	12	32	**36**	8	0	0	0	0	100	*0.36*
Fen	**9**	0	0	0	0	0	0	0	21	0	**79**	0	0	0	0	100	*0.79*
Rock	**10**	0	1	1	0	1	0	0	4	0	0	**73**	5	14	0	100	*0.73*
Glacier/snow field	**11**	0	0	0	0	0	0	0	0	0	0	3	**42**	52	3	100	*0.42*
Rock debris	**12**	0	1	0	0	0	0	0	5	0	0	9	8	**76**	0	100	*0.76*
Still water	**13**	6	0	0	0	0	0	0	0	0	6	0	0	0	**89**	100	*0.89*

Supplementary Table 7: Confusion matrix of the intersection of Maps 4 and 5a, including the producer's accuracy values

Ergänzende Tabelle 7: *Fehlermatrix für die Verschneidung von Karten 4 und 5a mit producer's accuracy Werten*

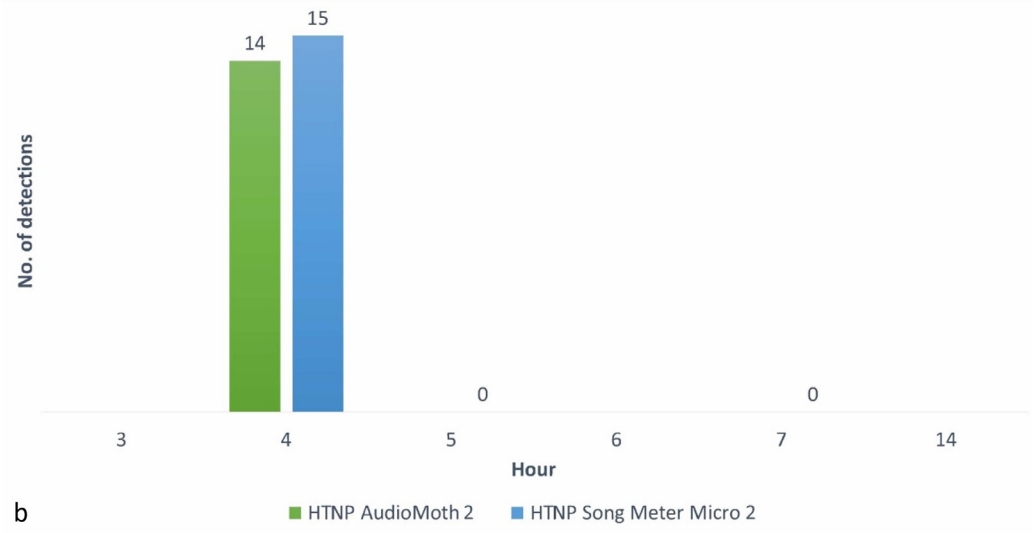
Blending tradition with innovation: how acoustic sensors are revolutionizing rock ptarmigan monitoring

Jennifer Lisa Insupp, Vanessa Berger, Gunther Greßmann



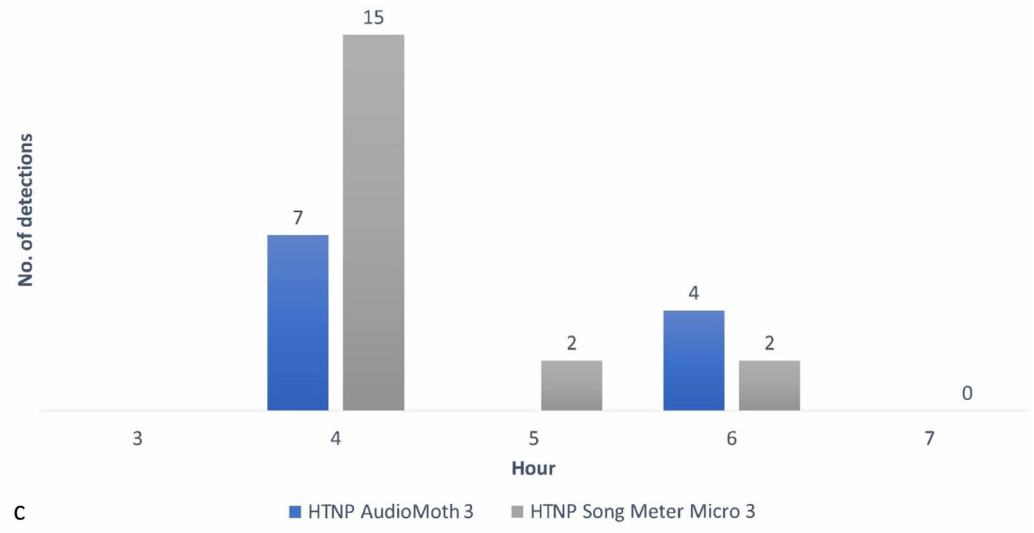
a

Suppl. Fig. 1a



b

Suppl. Fig. 1b

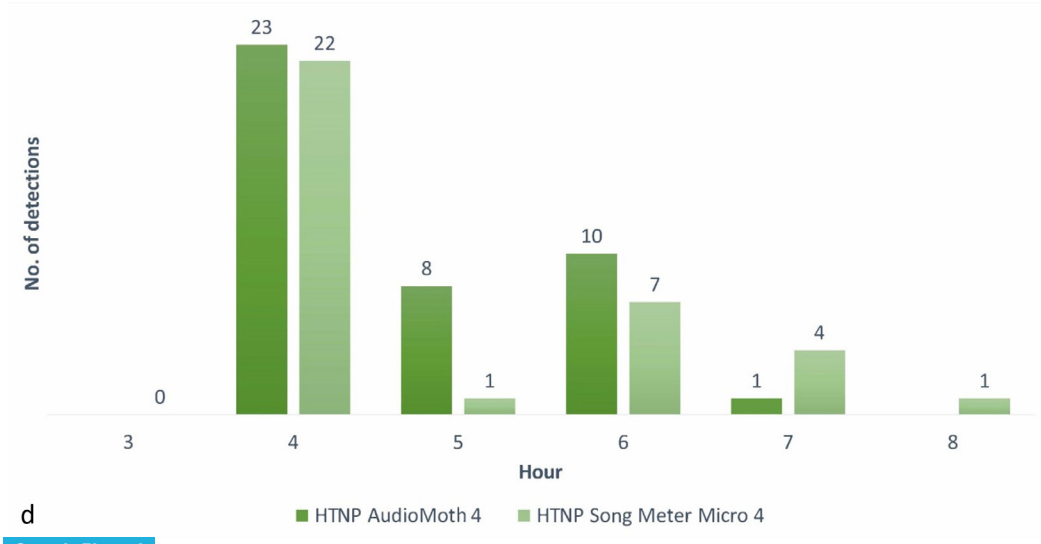


c

Suppl. Fig. 1c

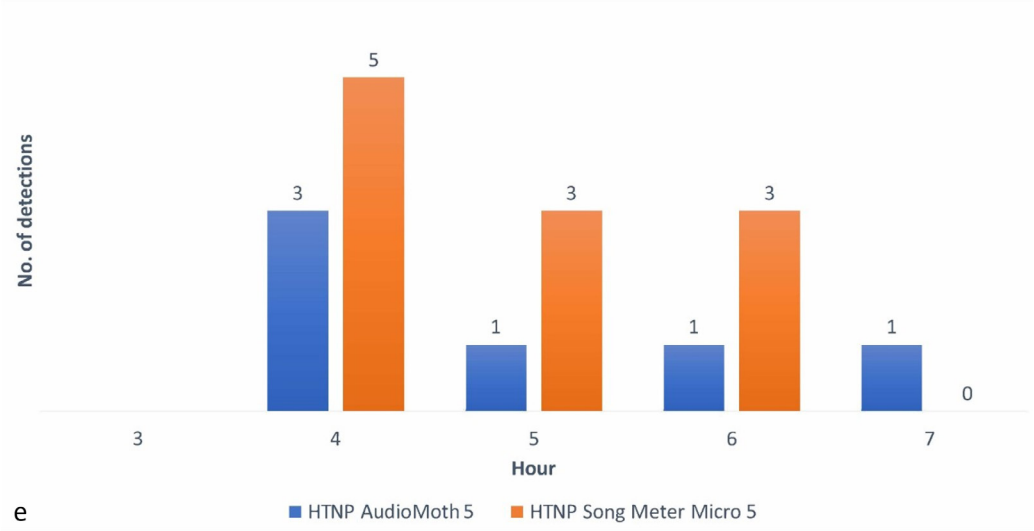
Supplementary Figure 1: Detections/hour for each site and device. Calls were counted once per minute of recording when they occurred (no multiple counts in one-minute recording). AudioMoth site 1 (a); AudioMoth and Song Meter Micro site 2 (b); AudioMoth and Song Meter Micro site 3 (c); AudioMoth and Song Meter Micro site 4 (d); AudioMoth and Song Meter Micro site site 5 (e). Source: own figure

Ergänzende Abbildung 1: *Rufnachweise pro Gerät und Tageszeit, Rufe wurden 1x pro Minute gezählt, wenn sie auftraten (keine Mehrfachzählungen innerhalb einer 1-minütigen Aufnahme). AudioMoth Fläche 1 (a); AudioMoth und Song Meter Micro Fläche 2 (b); AudioMoth und Song Meter Micro Fläche 3 (c); AudioMoth und Song Meter Micro Fläche 4 (d); AudioMoth und Song Meter Micro Fläche 5 (e). Quelle: eigene Abbildung*



d

Suppl. Fig. 1d



e

Suppl. Fig. 1e

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