Percent Canopy Cover of Trees and Shrubs within 100 meters of Frasier Creek
(Habitat Suitability Index Models: Minks SIV5 [1])

Vegetation Cover Type	SEGHAB[2]	Acres in 100m Buffer	Percent of Buffer	SEGHAB Average Percent Cover (Average of Tree/Shrub Cover for SEGHAB polygons)[3]	Weighted Mink Tree/Shrub Value (Percent of Buffer x SEGHAB average percent cover)
Agriculture	M-AG	4.29	4.85%	17.70	0.86
Mature Conifer	M-M	1.53	1.73%	100.00	1.73
Meadow	M-MD	1.48	1.68%	8.58	0.14
Mid-successional Conifer	M-MS	3.86	4.37%	96.98	4.23
Palustrine Forested Wetland	M-PFO	0.02	0.03%	67.89	0.02
Palustrine Unconsolidated Bottom	M-PUB	2.19	2.48%	0.00	0.00
Pole Conifer	M-P	5.99	6.78%	99.20	6.72
Pole Conifer (Thinned)	M-P-t	0.37	0.42%	83.67	0.35
Residential[4]	M-RES	1.08	1.22%	0.00	0.00
Right-of-way	M-ROW	1.30	1.47%	10.78	0.16
Riparian Deciduous	M-RD	8.67	9.80%	94.55	9.27
Riparian Mixed	M-RM	10.36	11.72%	96.30	11.28
Seedling/Sapling	M-SS	7.55	8.54%	56.81	4.85
Shrub	M-SH	0.47	0.53%	52.57	0.28
Upland Deciduous	M-UD	25.22	28.52%	97.18	27.72
Upland Mixed	M-UM	14.04	15.88%	96.69	15.35
Sum Total		**88.43**			**82.97**
Averages				61.18	5.19
X range = Range percent canopy cover of trees and shrubs within 100m of the water edge[1]	0.00	100.00	**Y range = Range of Suitability Index (SIV5)**[1]	0.10	1.00
		HSI Value for Sum Total of Weighted Mink Tree/Shrub Cover Value (82.97) =			**1.00**

[1] Allen, A.W. 1986. Habitat suitability index models: mink, revised. U.S.Fish Wildl. Serv. Biol. Rep. 82 (10.127). 23 PP. [First printed as: FWS/OBS-82/10.61, October 1983.]

[2] SEGHAB = Segment Habitat Type with segment being the reservoir analysis area (i.e., M= Merwin, Y=Yale) and habit type is equivalent of vegetation cover type. This is described in: PacifiCorp and Cowlitz PUD. 2004. Lewis River Hydroelectric Projects Technical Report 5.2 TER 2 Habitat Evaluation Procedures (HEP) Study. FERC Project Nos. 935, 2071, 2111, and 2213

[3] SEGHAB polygons tree/shrub Cover data averages are determined using the tree/shrub cover values in the SEGHAB_TreeShrubCover Spreadsheet. SEGHAB_TreeShrubCover spreadsheet was copied from LEWIS HSI122001.xls workbook Values spreadsheet located at S:\ENVSRVS\WILD\Hydro Projects\Lewis River\HEP Data\OriginalHEPdata

[4] Residential (M-RES) vegetation cover type was not included in the HEP study; therefore it does not have tree/shrub cover value. Because these areas are disturbed it assumed that the average tree/shrub cover values are 0.00.

Percent Canopy Cover of Trees and Shrubs within 100 meters of Speelyai Creek
(Habitat Suitability Index Models: Minks SIV5 [1])

Vegetation Cover Type	SEGHAB[2]	Acres in 100m Buffer	Percent of Buffer	SEGHAB Average Percent Cover (Average of Tree/Shrub Cover for SEGHAB polygons)[3]	Weighted Mink Tree/Shrub Value (Percent of Buffer x SEGHAB average percent cover)
Developed[4]	M-DV	0.47	0.58%	0.00	0.00
Mid-successional Conifer	M-MS	2.79	3.41%	96.98	3.31
Mid-successional Conifer	Y-MS	8.12	9.90%	95.30	9.44
Palustrine Forested Wetland	Y-PFO	0.48	0.58%	70.90	0.41
Right-of-way	M-ROW	1.49	1.82%	10.78	0.20
Right-of-way	Y-ROW	0.08	0.09%	8.30	0.01
Riparian Deciduous	Y-RD	21.24	25.91%	100.00	25.91
Riparian Mixed	M-RM	0.13	0.15%	96.30	0.15
Seedling/Sapling	M-SS	0.29	0.36%	56.81	0.20
Seedling/Sapling (New)[5]	Y-SS1	23.75	28.98%	4.50	1.30
Upland Deciduous	Y-UD	5.70	6.96%	97.04	6.75
Upland Mixed	M-UM	17.42	21.26%	96.69	20.56
Sum Total		**81.95**			**68.23**
Averages				61.13	5.69
X range = Range percent canopy cover of trees and shrubs within 100m of the water edge[1]	0.00	100.00	**Y range = Range of Suitability Index (SIV5)[1]**	0.10	1.00
		HSI Value for Sum Total of Weighted Mink Tree/Shrub Cover Value (68.23) =			**0.71**

[1] Allen, A.W. 1986. Habitat suitability index models: mink, revised. U.S.Fish Wildl. Serv. Biol. Rep. 82 (10.127). 23 PP. [First printed as: FWS/OBS-82/10.61, October 1983.]
[2] SEGHAB = Segment Habitat Type with the segment being the reservoir analysis area (i.e., M= Merwin, Y=Yale) and habit type is equivalent of vegetation cover type. This is described in: PacifiCorp and Cowlitz PUD. 2004. Lewis River Hydroelectric Projects Technical Report 5.2 TER 2 Habitat Evaluation Procedures (HEP) Study. FERC Project Nos. 935, 2071, 2111, and 2213

[3] SEGHAB polygons tree/shrub cover data averages are determined using the tree/shrub cover values in the SEGHAB_TreeShrubCover Spreadsheet. SEGHAB_TreeShrubCover spreadsheet wa copied from LEWIS HSI122001.xls workbook values spreadsheet located at S:\ENVSRVS\WILD\Hydro Projects\Lewis River\HEP Data\OriginalHEPdata

[4] Developed (M-DV) vegetation cover type was not included in the HEP study; therefore it does not have tree/shrub cover value. Because these areas are disturbed it assumed that the average tree/shrub cover values are 0.00.
[5] Seedling/Sapling (New) (Y-SS1) vegetation cover type does not have HEP polygons for Yale; therefore SEGHAB average percent cover was an average of M-SS1and SW-SS1 tree/shrub cover values.

Mink HEP Data

Location	Habitat Type	SEGHAB	HEP Polygon #	Max Length of Transect	Sum of Tree/Shrub Length	Percent of Tree/Shrub Cover	Average SEGHAB Tree/Shrub Percent Cover
Eagle Island	PFO	EI-PFO	3549	100	91.00	91.00	67.15
Eagle Island	PSS	EI-PSS	3544	100	44.90	44.90	67.15
Eagle Island	RD	EI-RD	3549	100	70.20	70.20	
Eagle Island	RD	EI-RD	3554	100	89.60	89.60	
Eagle Island	RD	EI-RD	3555	100	98.80	98.80	86.20
Eagle Island	RM	EI-RM	3546	100	96.40	96.40	96.40
Eagle Island	RS	EI-RS	3559	100	50.50	50.50	50.50
Eagle Island	RUB	EI-RUB	3543	100	0.00	0.00	
Eagle Island	RUB	EI-RUB	E.I.	50	0.00	0.00	0.00
Eagle Island	SH	EI-SH	3555b	50	30.30	60.60	60.60
Eagle Island	UD	EI-UD	3556	100	100.00	100.00	100.00
Eagle Island	YRM	EI-YRM	3545	100	85.20	85.20	85.20
L.M.	LUB	L.M.-LUB	XXXX		0.00	0.00	0.00
L.R.	RUB	L.R.-RUB	NORTH		0.00	0.00	0.00
Merwin S	AG	M-AG	3004	50	10.40	20.80	
Merwin S	AG	M-AG	3004b	100	14.60	14.60	17.70
Merwin N	LUB	M-LUB	x		0.00	0.00	
Merwin N	LUB	M-LUB	xx		0.00	0.00	
Merwin S	LUB	M-LUB	M.L.	5	0.00	0.00	
Merwin S	LUB	M-LUB	M.L.1	5	0.00	0.00	
Merwin S	LUB	M-LUB	x	5	0.00	0.00	0.00
Merwin N	M	M-M	2051	100	100.00	100.00	
Merwin S	M	M-M	2516	100	100.00	100.00	
Merwin S	M	M-M	2552	100	100.00	100.00	
Merwin S	M	M-M	2865	100	100.00	100.00	100.00
Merwin N	MD	M-MD	2355	100	34.30	34.30	
Merwin S	MD	M-MD	3059	50	0.00	0.00	
Merwin S	MD	M-MD	3064	100	0.00	0.00	
Merwin S	MD	M-MD	3165	100	0.00	0.00	8.58
Merwin N	MS	M-MS	1751	100	91.50	91.50	
Merwin N	MS	M-MS	1871	100	96.10	96.10	
Merwin N	MS	M-MS	2057	100	95.50	95.50	
Merwin N	MS	M-MS	2295	100	100.00	100.00	
Merwin N	MS	M-MS	2812	100	100.00	100.00	
Merwin N	MS	M-MS	3003	100	92.40	92.40	
Merwin N	MS	M-MS	3010	100	98.30	98.30	
Merwin S	MS	M-MS	2423	100	94.80	94.80	
Merwin S	MS	M-MS	2585	100	98.20	98.20	
Merwin S	MS	M-MS	2943	100	100.00	100.00	
Merwin S	MS	M-MS	2990	100	100.00	100.00	96.98
Merwin N	MS-T	M-MS-T	1725	100	94.70	94.70	
Merwin N	MS-T	M-MS-T	1918	100	93.30	93.30	
Merwin N	MS-T	M-MS-T	2114	100	95.90	95.90	
Merwin N	MS-T	M-MS-T	2357	100	96.90	96.90	
Merwin N	MS-T	M-MS-T	3828	100	60.70	60.70	
Merwin S	MS-T	M-MS-T	2719	100	46.90	46.90	
Merwin S	MS-T	M-MS-T	2836	100	61.60	61.60	
Merwin S	MS-T	M-MS-T	3237	100	84.50	84.50	79.31
Merwin N	OG	M-OG	1890	100	94.90	94.90	
Merwin N	OG	M-OG	2127	100	76.80	76.80	
Merwin N	OG	M-OG	2177	100	100.00	100.00	90.57
Merwin N	OR	M-OR	2320	90	47.40	52.67	
Merwin S	OR	M-OR	2833	100	64.70	64.70	
Merwin S	OR	M-OR	3052	50	10.40	20.80	46.06
Merwin N	OW	M-OW	1879	50	13.70	27.40	
Merwin N	OW	M-OW	2110	80	33.30	41.63	
Merwin N	OW	M-OW	2193	50	21.30	42.60	37.21
Merwin N	P	M-P	2550	100	100.00	100.00	
Merwin N	P	M-P	2750	100	97.40	97.40	
Merwin N	P	M-P	2759	100	97.80	97.80	

Mink HEP Data

Location	Habitat Type	SEGHAB	HEP Polygon #	Max Length of Transect	Sum of Tree/Shrub Length	Percent of Tree/Shrub Cover	Average SEGHAB Tree/Shrub Percent Cover
Merwin S	P	M-P	424	100	100.00	100.00	
Merwin S	P	M-P	2676	100	99.30	99.30	
Merwin S	P	M-P	2720	100	100.00	100.00	
Merwin S	P	M-P	2722	100	99.10	99.10	
Merwin S	P	M-P	3180	100	100.00	100.00	99.20
Merwin N	PEM	M-PEM	2123	100	7.40	7.40	
Merwin S	PEM	M-PEM	3107	50	0.00	0.00	3.70
Merwin N	PFO	M-PFO	1974	100	68.60	68.60	
Merwin N	PFO	M-PFO	2792	100	87.10	87.10	
Merwin S	PFO	M-PFO	3166	124	59.50	47.98	67.89
Merwin N	PSS	M-PSS	3058	100	93.30	93.30	
Merwin N	PSS	M-PSS	3069	100	34.40	34.40	63.85
Merwin N	P-T	M-P-T	1993	100	98.30	98.30	
Merwin N	P-T	M-P-T	2608	100	77.80	77.80	
Merwin N	P-T	M-P-T	2651	100	90.30	90.30	
Merwin S	P-T	M-P-T	3221	100	82.90	82.90	87.33
Merwin N	PUB	M-PUB	3008	100	0.00	0.00	
Merwin N	PUB	M-PUB	3106	110	0.00	0.00	
Merwin S	PUB	M-PUB	3186	116		0.00	
Merwin S	PUB	M-PUB	3209	100	0.00	0.00	0.00
Merwin N	RD	M-RD	1829	100	95.00	95.00	
Merwin N	RD	M-RD	3369	100	94.10	94.10	94.55
Merwin N	RM	M-RM	1780	100	92.20	92.20	
Merwin N	RM	M-RM	2549	100	96.70	96.70	
Merwin S	RM	M-RM	2894	100	100.00	100.00	96.30
Merwin N	ROW	M-ROW	1933	100	0.00	0.00	
Merwin N	ROW	M-ROW	2045	100	13.80	13.80	
Merwin N	ROW	M-ROW	2723	100	22.30	22.30	
Merwin N	ROW	M-ROW	3449	50	4.10	8.20	
Merwin S	ROW	M-ROW	3205	100	11.40	11.40	
Merwin S	ROW	M-ROW	3370	50	4.50	9.00	10.78
Merwin N	RS	M-RS	2582	80	79.20	99.00	
Merwin S	RS	M-RS	3377	80	63.10	78.88	88.94
Merwin N	SH	M-SH	1956	100	94.20	94.20	
Merwin N	SH	M-SH	1990	50	14.60	29.20	
Merwin S	SH	M-SH	3055	100	34.30	34.30	52.57
Merwin N	SS	M-SS	1724	100	55.40	55.40	
Merwin N	SS	M-SS	1977	100	30.80	30.80	
Merwin N	SS	M-SS	2521	50	30.40	60.80	
Merwin N	SS	M-SS	3085	100	97.70	97.70	
Merwin N	SS	M-SS	3112	100	20.20	20.20	
Merwin S	SS	M-SS	3158	50	40.20	80.40	
Merwin S	SS	M-SS	3232	100	52.40	52.40	56.81
Merwin N	SSI	M-SSI	2071	100	23.00	23.00	
Merwin N	SSI	M-SSI	2212	100	0.70	0.70	
Merwin N	SSI	M-SSI	2656	100	9.80	9.80	
Merwin S	SSI	M-SSI	3067	100	31.80	31.80	
Merwin S	SSI	M-SSI	3088	100	0.40	0.40	
Merwin S	SSI	M-SSI	3222	100	0.00	0.00	10.95
Merwin N	UD	M-UD	1831	100	100.00	100.00	
Merwin N	UD	M-UD	2058	100	100.00	100.00	
Merwin N	UD	M-UD	2934	100	97.50	97.50	
Merwin N	UD	M-UD	2942	50	43.70	87.40	
Merwin S	UD	M-UD	2679	100	98.20	98.20	
Merwin S	UD	M-UD	3105	100	100.00	100.00	97.18
Merwin N	UM	M-UM	1702	100	97.00	97.00	
Merwin N	UM	M-UM	1900	100	97.40	97.40	
Merwin N	UM	M-UM	1975	80	70.00	87.50	
Merwin N	UM	M-UM	2142	100	100.00	100.00	
Merwin N	UM	M-UM	2866	100	99.50	99.50	

Mink HEP Data

Location	Habitat Type	SEGHAB	HEP Polygon #	Max Length of Transect	Sum of Tree/Shrub Length	Percent of Tree/Shrub Cover	Average SEGHAB Tree/Shrub Percent Cover
Merwin N	UM	M-UM	3097	100	99.50	99.50	
Merwin S	UM	M-UM	2382	100	94.00	94.00	
Merwin S	UM	M-UM	2383	100	94.00	94.00	
Merwin S	UM	M-UM	2715	75	73.50	98.00	
Merwin S	UM	M-UM	2895	100	100.00	100.00	96.69
Merwin N	UM-T	M-UM-T	2462	100	87.60	87.60	87.60
Merwin N	YUD	M-YUD	1698	100	98.00	98.00	
Merwin S	YUD	M-YUD	2513	100	96.60	96.60	97.30
Merwin N	YUM	M-YUM	1668	100	100.00	100.00	
Merwin N	YUM	M-YUM	1783	100	80.80	80.80	
Merwin S	YUM	M-YUM	2559	100	83.80	83.80	88.20
Swift Canal	LP	SBC-LP	730	100	66.80	66.80	
Swift Canal	LP	SBC-LP	730a	100	85.20	85.20	
Swift Canal	LP	SBC-LP	731a	100	51.40	51.40	67.80
Swift Canal	MD	SBC-MD	759	50	17.50	35.00	35.00
Swift Canal	MS	SBC-MS	576	100	76.20	76.20	
Swift Canal	MS	SBC-MS	670	100	99.20	99.20	
Swift Canal	MS	SBC-MS	679	100	98.00	98.00	91.13
Swift Bypass	P	SBC-P	703	100	100.00	100.00	
Swift Bypass	P	SBC-P	906	100	79.50	79.50	89.75
Swift Canal	PEM	SBC-PEM	551	100	3.20	3.20	
Swift Canal	PEM	SBC-PEM	554	100	0.80	0.80	2.00
Swift Bypass	PFO	SBC-PFO	684	100	98.00	98.00	
Swift Bypass	PFO	SBC-PFO	707	100	63.60	63.60	80.80
Swift Bypass	PSS	SBC-PSS	829	100	44.50	44.50	
Swift Canal	PSS	SBC-PSS	533	100	44.30	44.30	44.40
Swift Bypass	PUB	SBC-PUB	740	100	0.00	0.00	
Swift Bypass	PUB	SBC-PUB	NWS POND	100	0.00	0.00	
Swift Canal	PUB	SBC-PUB	581	100	0.00	0.00	
Swift Canal	PUB	SBC-PUB	603	100	0.00	0.00	0.00
Swift Bypass	RD	SBC-RD	813	100	100.00	100.00	
Swift Bypass	RD	SBC-RD	707b	100	97.90	97.90	
Swift Canal	RD	SBC-RD	519	100	94.40	94.40	
Swift Canal	RD	SBC-RD	557	100	100.00	100.00	
Swift Canal	RD	SBC-RD	762	100	80.60	80.60	94.58
Swift Bypass	RM	SBC-RM	750	100	96.50	96.50	96.50
Swift Canal	ROW	SBC-ROW	518	100	12.20	12.20	
Swift Canal	ROW	SBC-ROW	531	100	4.10	4.10	8.15
Swift Bypass	RS	SBC-RS	889	100	52.50	52.50	
Swift Canal	RS	SBC-RS	691	100	79.30	79.30	65.90
Swift Bypass	RUB	SBC-RUB	1	100	0.00	0.00	
Swift Bypass	RUB	SBC-RUB	2	100	0.00	0.00	
Swift Bypass	RUB	SBC-RUB	3	100	0.00	0.00	0.00
Swift Bypass	SH	SBC-SH	747	50	10.20	20.40	20.40
Swift Bypass	UD	SBC-UD	700	50	50.00	100.00	
Swift Canal	UD	SBC-UD	550	100	100.00	100.00	
Swift Canal	UD	SBC-UD	519A	100	97.30	97.30	99.10
Swift Canal	UM	SBC-UM	654	100	91.90	91.90	
Swift Canal	UM	SBC-UM	745	100	86.70	86.70	89.30
Swift	LUB	SW-LUB	S.L.	5	0.00	0.00	0.00
Swift	M	SW-M	323	100	95.70	95.70	
Swift	M	SW-M	341	100	98.90	98.90	
Swift	M	SW-M	552	100	94.20	94.20	
Swift	M	SW-M	1030	100	98.80	98.80	
Swift	M	SW-M	1076	100	100.00	100.00	97.52
Swift	MD	SW-MD	456	50	13.80	27.60	27.60
Swift	MS	SW-MS	111	100	100.00	100.00	
Swift	MS	SW-MS	180	100	82.00	82.00	
Swift	MS	SW-MS	392	100	100.00	100.00	

Mink HEP Data

Location	Habitat Type	SEGHAB	HEP Polygon #	Max Length of Transect	Sum of Tree/Shrub Length	Percent of Tree/Shrub Cover	Average SEGHAB Tree/Shrub Percent Cover
Swift	MS	SW-MS	415	100	98.40	98.40	
Swift	MS	SW-MS	1057	100	100.00	100.00	96.08
Swift	OG	SW-OG	28	100	100.00	100.00	
Swift	OG	SW-OG	66	100	95.70	95.70	
Swift	OG	SW-OG	340	100	97.00	97.00	
Swift	OG	SW-OG	1163	100	100.00	100.00	
Swift	OG	SW-OG	1165	100	100.00	100.00	
Swift	OG	SW-OG	1219	100	96.80	96.80	98.25
Swift	P	SW-P	94	100	94.30	94.30	
Swift	P	SW-P	167	100	97.90	97.90	
Swift	P	SW-P	214	100	100.00	100.00	
Swift	P	SW-P	248	100	99.30	99.30	
Swift	P	SW-P	377	100	95.90	95.90	
Swift	P	SW-P	1143	100	97.20	97.20	97.43
Swift	PEM	SW-PEM	223	60	13.30	22.17	22.17
Swift	PFO	SW-PFO	320	100	57.90	57.90	
Swift	PFO	SW-PFO	651	100	90.10	90.10	74.00
Swift	PSS	SW-PSS	70	100	67.60	67.60	67.60
Swift	PUB	SW-PUB	70	50	50.00	100.00	
Swift	PUB	SW-PUB	406	100	0.00	0.00	50.00
Swift	RD	SW-RD	369	100	100.00	100.00	
Swift	RD	SW-RD	843	100	100.00	100.00	
Swift	RD	SW-RD	1215	100	91.00	91.00	
Swift	RD	SW-RD	1242	100	100.00	100.00	97.75
Swift	RM	SW-RM	235	100	99.60	99.60	
Swift	RM	SW-RM	321	100	100.00	100.00	
Swift	RM	SW-RM	1106	100	100.00	100.00	99.87
Swift	RS	SW-RS	1303	100	51.70	51.70	51.70
Swift	SH	SW-SH	1340	100	32.90	32.90	32.90
Swift	SS	SW-SS	107	100	80.30	80.30	
Swift	SS	SW-SS	108	100	61.00	61.00	
Swift	SS	SW-SS	116	100	45.60	45.60	
Swift	SS	SW-SS	162	100	22.90	22.90	
Swift	SS	SW-SS	391	100	95.50	95.50	61.06
Swift	SSI	SW-SSI	82	100	8.90	8.90	
Swift	SSI	SW-SSI	324	100	0.10	0.10	4.50
Swift	UD	SW-UD	216	100	99.20	99.20	
Swift	UD	SW-UD	387	100	95.70	95.70	
Swift	UD	SW-UD	500	100	100.00	100.00	
Swift	UD	SW-UD	516	100	100.00	100.00	98.73
Swift	UM	SW-UM	78	100	85.70	85.70	
Swift	UM	SW-UM	410	100	100.00	100.00	
Swift	UM	SW-UM	433	100	88.80	88.80	
Swift	UM	SW-UM	435	100	100.00	100.00	
Swift	UM	SW-UM	1017	100	100.00	100.00	
Swift	UM	SW-UM	1071	50	47.10	94.20	94.78
Swift	YUD	SW-YUD	194	100	100.00	100.00	
Swift	YUD	SW-YUD	318	100	100.00	100.00	100.00
Yale N	AG	Y-AG	1916	100	0.00	0.00	
Yale N	AG	Y-AG	2807	100	16.00	16.00	8.00
Yale N	LP	Y-LP	412	100	43.90	43.90	
Yale N	LP	Y-LP	413	100	53.20	53.20	
Yale N	LP	Y-LP	731	100	45.20	45.20	47.43
Yale	LUB	Y-LUB	NORTH		0.00	0.00	
Yale	LUB	Y-LUB	SOUTH		0.00	0.00	0.00
Yale N	M	Y-M	595	100	100.00	100.00	
Yale N	M	Y-M	1482	100	96.60	96.60	
Yale S	M	Y-M	802	100	84.60	84.60	
Yale S	M	Y-M	3077	100	77.50	77.50	89.68
Yale N	MS	Y-MS	644	100	96.70	96.70	

Mink HEP Data

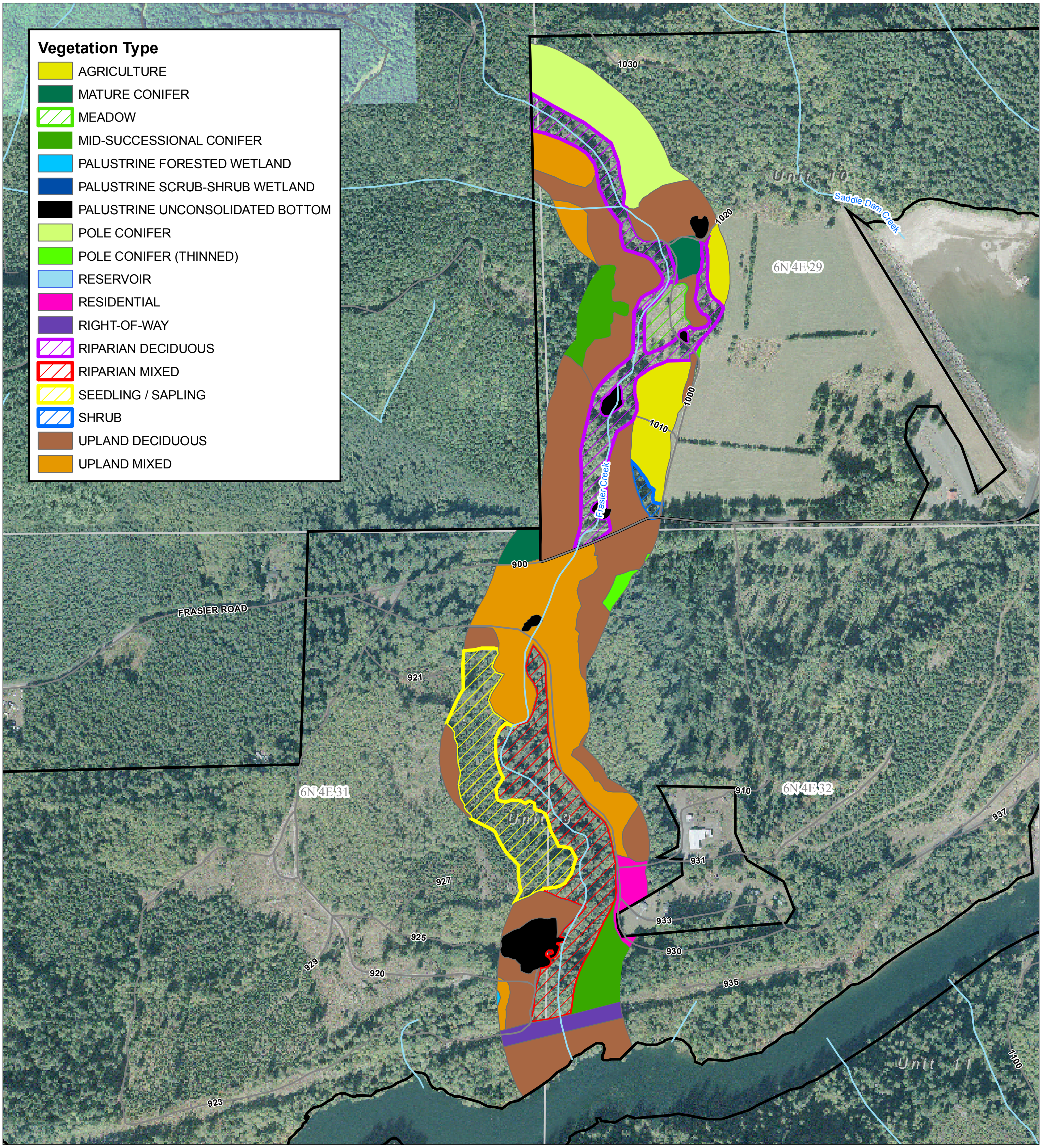
Location	Habitat Type	SEGHAB	HEP Polygon #	Max Length of Transect	Sum of Tree/Shrub Length	Percent of Tree/Shrub Cover	Average SEGHAB Tree/Shrub Percent Cover
Yale N	MS	Y-MS	1272	100	97.90	97.90	
Yale N	MS	Y-MS	1493	78	78.00	100.00	
Yale N	MS	Y-MS	1573	100	97.70	97.70	
Yale N	MS	Y-MS	1600	100	96.00	96.00	
Yale N	MS	Y-MS	1833	100	99.00	99.00	
Yale S	MS	Y-MS	1231	100	85.20	85.20	
Yale S	MS	Y-MS	2307	100	94.90	94.90	
Yale S	MS	Y-MS	3087	100	90.30	90.30	95.30
Yale N	OG	Y-OG	264	100	69.10	69.10	
Yale S	OG	Y-OG	770	100	94.00	94.00	
Yale S	OG	Y-OG	2418	100	94.80	94.80	85.97
Yale N	OR	Y-OR	2831	50	13.70	27.40	
Yale N	OR	Y-OR	2887	50	3.30	6.60	17.00
Yale N	P	Y-P	371	100	98.90	98.90	
Yale N	P	Y-P	2126	100	98.10	98.10	
Yale N	P	Y-P	2198	100	100.00	100.00	
Yale S	P	Y-P	1337	100	90.30	90.30	
Yale S	P	Y-P	1337b	100	100.00	100.00	97.46
Yale N	PEM	Y-PEM	662	50	50.00	100.00	
Yale N	PEM	Y-PEM	2546	100	7.70	7.70	
Yale S	PEM	Y-PEM	3131	100	0.00	0.00	35.90
Yale N	PFO	Y-PFO	573	100	50.00	50.00	
Yale N	PFO	Y-PFO	1858	100	64.00	64.00	
Yale S	PFO	Y-PFO	3130	100	36.90	36.90	
Yale S	PFO	Y-PFO	3142	100	88.40	88.40	
Yale S	PFO	Y-PFO	3130b	100	98.00	98.00	
Yale S	PFO	Y-PFO	UNK	100	88.10	88.10	70.90
Yale N	PSS	Y-PSS	639	100	0.00	0.00	
Yale N	PSS	Y-PSS	2414	100	50.00	50.00	25.00
Yale S	P-T	Y-P-T	3109	100	60.80	60.80	60.80
Yale N	PUB	Y-PUB	640	100	0.00	0.00	
Yale N	PUB	Y-PUB	CGP	116	0.00	0.00	
Yale S	PUB	Y-PUB	3116	100	0.00	0.00	
Yale S	PUB	Y-PUB	3117	60	0.00	0.00	
Yale S	PUB	Y-PUB	3118	28	0.00	0.00	
Yale S	PUB	Y-PUB	3116b	43	0.00	0.00	0.00
Yale N	RD	Y-RD	2268	100	100.00	100.00	100.00
Yale N	RM	Y-RM	697	100	83.50	83.50	
Yale N	RM	Y-RM	761	100	95.50	95.50	89.50
Yale N	ROW	Y-ROW	1044	100	4.20	4.20	
Yale N	ROW	Y-ROW	1458	100	12.40	12.40	8.30
Yale N	RS	Y-RS	2441	100	33.90	33.90	33.90
Yale N	SH	Y-SH	1565	100	100.00	100.00	
Yale N	SH	Y-SH	1587	50	50.00	100.00	100.00
Yale N	SS	Y-SS	515	100	13.30	13.30	
Yale N	SS	Y-SS	2440	100	37.80	37.80	
Yale S	SS	Y-SS	2014	100	28.10	28.10	26.40
Yale N	UD	Y-UD	875	100	100.00	100.00	
Yale S	UD	Y-UD	768	100	99.90	99.90	
Yale S	UD	Y-UD	989	100	95.80	95.80	
Yale S	UD	Y-UD	1365	100	93.40	93.40	
Yale S	UD	Y-UD	2627	100	93.80	93.80	
Yale S	UD	Y-UD	3235	100	98.70	98.70	
Yale S	UD	Y-UD	2627a	100	97.70	97.70	97.04
Yale N	UM	Y-UM	254	100	100.00	100.00	
Yale N	UM	Y-UM	2415	100	98.30	98.30	
Yale S	UM	Y-UM	1274	100	94.30	94.30	
Yale S	UM	Y-UM	2218	100	93.20	93.20	
Yale S	UM	Y-UM	3007	100	88.00	88.00	94.76
Yale N	YUD	Y-YUD	418	50	50.00	100.00	100.00

Mink HEP Data

Location	Habitat Type	SEGHAB	HEP Polygon #	Max Length of Transect	Sum of Tree/Shrub Length	Percent of Tree/Shrub Cover	Average SEGHAB Tree/Shrub Percent Cover

Only one percent cover average was determined for mink tree/shrub cover within 100m of water's edge (Mink HSI model variable SIV5) for each project segment area (Eagle Island, Merwin, Yale, Swift, Swift Canal). These average percent cover values were used to determine the overall HSI mink values for Lacustrine (Reservoir) (LUB), palustrine emergent (PEM), palustrine scrub-shrub (PSS), palustrine forested (PFO), palustrine unconsolidated bottom (PUB), riverine (RUB) vegetation cover types within the project segment. This was completed by:

1. GIS was used to determine the acreage of each vegetation cover type within the 100 m buffer around all wetlands (PEM, PFO, PSS, PUB), river (RUB), and reservoir (LUB) in each project segment.
2. The acreages for each vegetation cover type were converted to percentages of the total buffer area in each project segment. For example, 12.5% OG 55.5% MS, 5% RD, 4% PFO, 3% PSS, 20% developed.
3. The combined tree/shrub cover from corresponding SEGHAB field data was used to determine each SEGHAB average percent tree/shrub cover
4. The SEGHAB average percent tree/shrub cover was then multiplied by the percentage of the respective cover type in the buffer areas.
5. These products were then summed to get a weighted average for tree/shrub cover in the buffer.
6. This sum was used to determine an overall HSI model SIV5 (tree/shrub cover within 100 m) for each reservoir analysis area



Lewis River
Vegetation Types within 100m of Frasier Creek

N W E S

0 500 1,000 Feet

Legend
- Streams
- Roads
- Section
- Management Unit

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Data are projected in UTM Zone 10, NAD83, meters.

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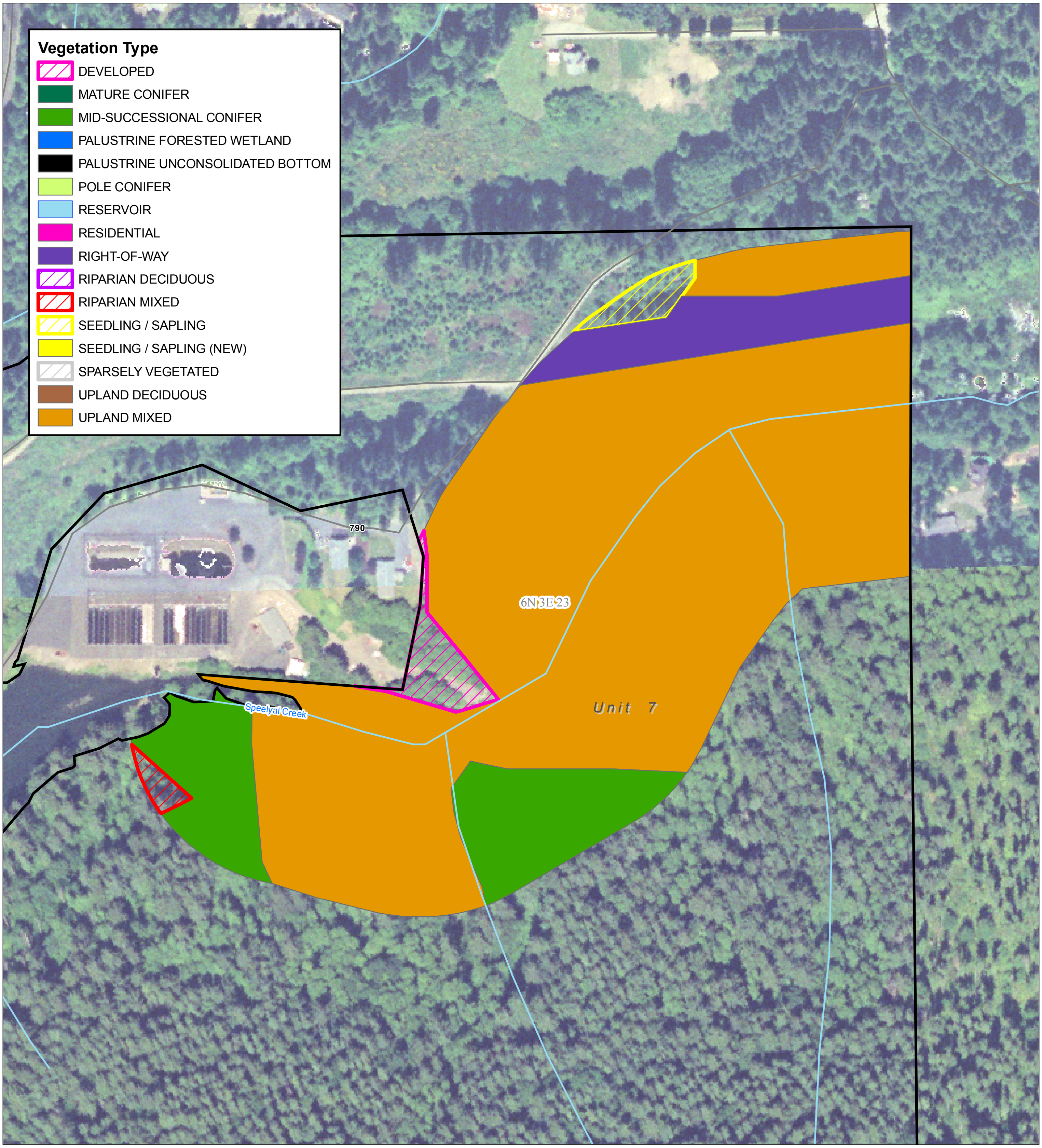

Lewis River

Vegetation Types within 100m of Speelyai Creek

Unit 7

0 250 500 Feet

N W E S

Legend

- Streams
- Roads
- Section
- Management Unit

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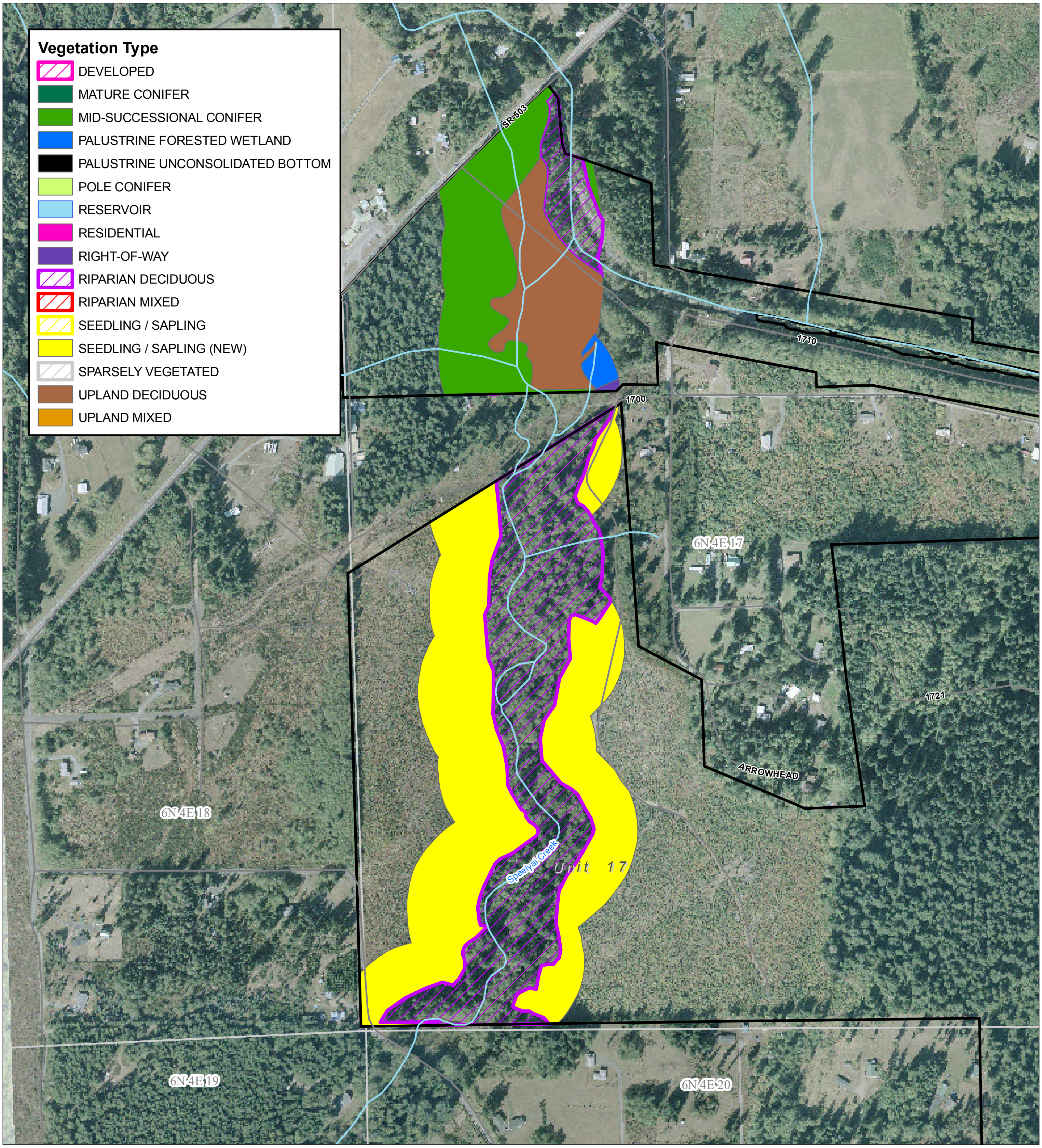

Lewis River

Vegetation Types within 100m of Speelyai Creek

Unit 17

N W E S

0 500 1,000 Feet

Legend

- Streams
- Roads
- Section
- Management Unit

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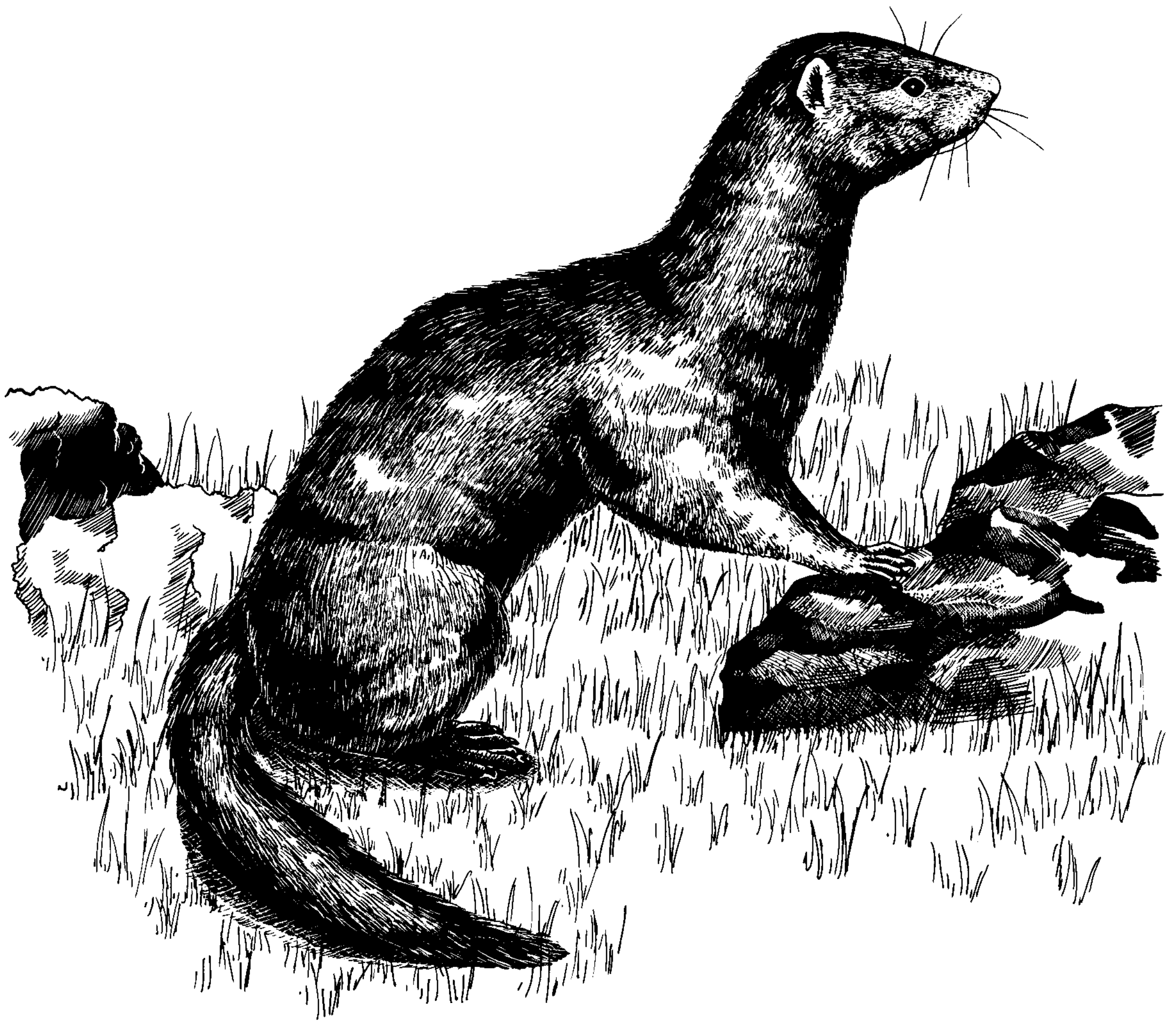
HABITAT SUITABILITY INDEX MODELS: MINK



Fish and Wildlife Service

. Department of the Interior

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November 1986 Revised

HABITAT SUITABILITY INDEX MODELS: MINK

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PREFACE

This document is part of the Habitat Suitability Index (HSI) Model Series (FWS/OBS-82/10), which provides habitat information useful for impact assessment and habitat management. Several types of habitat information are provided. The Habitat Use Information Section is largely constrained to those data that can be used to derive quantitative relationships between key environmental variables and habitat suitability. The habitat use information provides the foundation for HSI models that follow. In addition, this same information may be useful in the development of other models more appropriate to specific assessment or evaluation needs.

The HSI Model Section documents a habitat model and information pertinent to its application. The model synthesizes the habitat use information into a framework appropriate for field application and is scaled to produce an index value between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). The application information includes descriptions of the geographic ranges and seasonal application of the model, its current verification status, and a listing of model variables with recommended measurement techniques for each variable.

In essence, the model presented herein is a hypothesis of species-habitat relationships and not a statement of proven cause and effect relationships. Results of model performance tests, when available, are referenced. However, models that have demonstrated reliability in specific situations may prove unreliable in others. For this reason, feedback is encouraged from users of this model concerning improvements and other suggestions that may increase the utility and effectiveness of this habitat-based approach to fish and wildlife planning. Please send suggestions to:

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CONTENTS

FIGURES

ACKNOWLEDGMENTS

Dr. Johnny Birks, University of Durham, Durham, Great Britain; Dr. Paul Chanin, University of Exeter, Devon, Great Britain; Dr. Thomas Eagle, University of Minnesota, Minneapolis, MN; Mr. John Hunt, Maine Department of Inland Fisheries and Wildlife, Augusta, ME; Mr. Noel Kinler, Louisiana Department of Wildlife and Fisheries, New Iberia, LA; Mr. Ian Linn, University of Exeter, Hatherly Laboratories, Exeter, Great Britain; Mr. Greg Linscombe, Louisiana Department of Wildlife and Fisheries, New Iberia, LA; Mr. John Major, Maine Cooperative Wildlife Research Unit, University of Maine, Orono, ME; and Mr. Barry Saunders, Ministry of Environment, British Columbia, Canada; provided valuable critiques of earlier drafts of the HSI model for mink. The comments and suggestions of these individuals have added significantly to the quality of this HSI model, and their contributions are gratefully acknowledged. The cover of this document was illustrated by Jennifer Shoemaker. Word processing was provided by Carolyn Gulzow, Dora Ibarra, Elizabeth Barstow, and Patricia Gillis.

MINK (Mustela vison)

HABITAT USE INFORMATION

General

The mink (Mustela vison) is a predatory, semiaquatic mammal that is generally associated with stream and river banks, lake shores, freshwater and saltwater marshes, and marine shore habitats (Gerell 1970). Mink are chiefly nocturnal and remain active throughout the year (Marshall 1936; Gerell 1969; Burgess 1978). The species is adaptable in its use of habitat, modifying daily habits according to environmental conditions, particularly prey availability (Linn and Birks 1981; Wise et al. 1981; Birks and Linn 1982). The species is tolerant of human activity and will inhabit suboptimum habitats as long as an adequate food source is available; however, mink will be more mobile and change home ranges more frequently under such conditions (Linn, pers. comm.).

Food

The mink's foraging niche is typically associated with aquatic habitats (Gerell 1969; Eberhardt and Sargeant 1977; Chanin and Linn 1980; Wise et al. 1981). The species exhibits considerable variation in its diet, according to season, prey availability, and habitat type (Burgess 1978; Chanin and Linn 1980; Melquist et al. 1981; Wise et al. 1981; Linscombe et al. 1982; Smith and McDaniel 1982). Habitat quality influences the distribution, density, and reliability of prey, which, in turn, directly affect mink population density and distribution (King 1983). Management practices intended to enhance mink populations should address the maintenance or improvement of habitat diversity to sustain or increase the abundance and diversity of prey, rather than attempting to manage prey species themselves (Casson and Klimstra 1983). Predation by mink in North Dakota appeared to be directed toward the most vulnerable individuals among available prey species (Sargeant et al. 1973). Preferred mink prey can be broadly categorized into three groups: (1) aquatic [e.g., fish and crayfish (Cambarus spp.)]; (2) semiaquatic [e.g., waterfowl and water associated mammals, such as the muskrat (Ondatra zibethicus)]; and (3) terrestrial [e.g., rabbits (Lagomorpha) and rodents (Rodentia)] (Chanin, pers. comm.). If prey in any of these categories is available throughout the year, the habitat may be suitable for mink.

Fish occurred more frequently (59%) in the mink's diet in Idaho than did any other prey category (Melquist et al. 1981). Unidentified cyprinids (Cyprinidae), ranging in length from 7 to 12 cm were the major group of prey fish. Larger fish, represented by salmonids (Salmonidae), accounted for 9% of the diet. These larger fish were believed too large for mink to prey on and were probably scavenged. Fish, shellfish, and crustaceans were the major food items of mink inhabiting coastal habitats of Alaska and British Columbia (Harbo 1958, cited by Pendleton 1982; Hatler 1976).

Eberhardt and Sargeant (1977) reported that birds, mammals, amphibians, and reptiles accounted for 78%, 19%, 2%, and 1%, respectively, of the vertebrate prey consumed by mink in North Dakota prairie marshes. Waterfowl accounted for 86% of the avian prey, with coots (Fulica americana), ducks (Anatidae), and grebes (Podicipedidae) comprising 70%, 11%, and 5% of the total. The relative amount of each prey species eaten closely paralleled the relative abundance of the species. The high use of avian prey in North Dakota prairie marshes was believed to be a result of high waterfowl densities and the scarcity of other prey species, particularly fish and crayfish. Talent et al. (1983) concluded that predation by mink was the principle cause of duckling mortality in their North Dakota study. Waterfowl were also an important component of the diet of mink in Idaho during spring and early summer when young ducks were abundant (Melquist et al. 1981). Fish, crayfish, rodents, and birds are the principal prey of mink in Sweden (Gerell 1969). Fish are preferentially consumed in winter and spring due to their increased vulnerability, resulting from low water levels and low temperatures. Crayfish occurred most frequently in the mink's diet during the summer months in Sweden (Gerell 1967). Crayfish were also the most important component of the mink's summer diet in Quebec (Burgess 1978). Crayfish are a prominent component of the mink's diet in Louisiana and, when abundant, support high mink populations (Lowery 1974; Linscombe and Kinler, pers. comm.). Mink populations in Louisiana are believed to cycle with, or slightly behind peaks in crayfish populations (Linscombe and Kinler, pers. comm.).

With the approach of fall, small terrestrial mammals play an increasingly important role in the mink's diet (Gerell 1967, 1969; Burgess 1978; Casson and Klimstra 1983). Small mammals associated with riparian habitats accounted for 43% of the mink's diet in Idaho (Melquist et al. 1981). Small mammals accounted for more than 20% of the fall/winter diet in North Carolina (Wilson 1954). Terrestrial prey species in Great Britain may be of equal importance in the mink's diet as are aquatic prey species (Birks, pers. comm.). Rabbits are of major importance in the mink's diet even in areas where aquatic prey is abundant (Birks and Dunstone 1984). Muskrats have been reported to be a notable part of the mink's diet throughout its range (Hamilton 1940). However, Errington (1943) believed that muskrats became a significant food source for mink only during periods of muskrat overpopulation, epidemic diseases of muskrats, or drought. Sealander (1943) reported that muskrats were a major component of the winter diet of mink in southern Michigan. Muskrats were the most important component of the mink's diet in Ontario (McDonnell and Gilbert 1981). Predation on muskrats increased during the fall months as marsh water level decreased. Melquist et al. (1981) believed that only adult male mink were large enough to consistently prey upon muskrats.

Female mink in Illinois consumed greater numbers of small mammals [e.g., mice and voles (Cricetidae)] than did males, which tended to prey on larger mammals, such as muskrats and rabbits (Casson and Klimstra 1983). Birks and Dunstone (1985) concluded that female mink, because of their relatively small size, predominantly prey on items that are small and of aquatic origin, whereas males are apparently large enough to specialze on larger prey, such as rabbits. Predation by female mink on rabbits did increase during summer when juveniles were available.

Water

The majority of mink activity in Quebec was within 3 m of the edges of streams (Burgess 1978). All of the mink observations in a Michigan study were within 30.4 m of the water's edge (Marshall 1936). The majority of mink den sites recorded in a British study were within 10 m of the water's edge (Birks and Linn 1982). Mink den sites in Minnesota were within 69.9 m of open water (Schladweiler and Storm 1969). Den sites in Idaho were 5 to 100 m from water, and mink were never observed further than 200 m from water (Melquist et al. 1981). Mink activity in Quebec dropped sharply as stream flow increased (Burgess 1978). Korschgen (1958) reported that the use of aquatic foods by mink in Missouri increased as water levels decreased.

Cover

Mink in Michigan (Marshall 1936) and Sweden (Gerell 1970) are most commonly associated with brushy or wooded cover adjacent to aquatic habitats. Mink in a Quebec study were normally most active in wooded areas immediately adjacent to a stream channel (Burgess 1978). During the latter part of the summer, when terrestrial foods became a more significant component of the mink's diet, this relationship became less well defined. In England, mink movements of up to approximately 200 m from water are not uncommon, particularly when aquatic prey is scarce (Linn and Birks 1981). When upland habitats are used by mink, ecotones receive most use due to increased cover and small mammal availability. Mink generally avoid exposed or open areas (Gerell 1970; Burgess 1978). Shrubby vegetation furnishing a dense tangle provides suitable cover for mink (Linn, pers. comm.). Grasses, even if very tall, usually do not provide adequate year-round cover for the species. However, harvest data in Louisiana suggest that marshes containing dense stands of sawgrass (Cladium jamaicense) support high densities of mink (Linscombe and Kinler, pers. comm.). Thick stands of sawgrass are believed to provide excellent cover, elevation above the water level, and prey for mink. However, significantly more mink are captured in southern Louisiana swamps than marshes (Nichols and Chabreck 1981). The greater abundance of mink in cypress-tupelo (Taxodium distichum - Nyssa aquatica) swamps is partially attributed to a greater abundance of food resources and potential den sites than are present in marsh habitats. These findings are consistent with the belief that cypress-tupelo swamps are Louisiana's best mink producing areas (St. Amant 1959, cited by Nichols and Chabreck 1981).

Gerell (1970) characterized mink habitat in Sweden as small, oligotrophic lakes with stony shores, and streams surrounded by marsh vegetation. The shores of wetland habitats with dense vegetation are the most suitable mink habitat in Michigan (Marshall 1936) and England (Linn and Stevenson 1980; Mason and MacDonald 1983). Virtually all mink locations recorded in a North Dakota study were within 20 m of emergent vegetation (Eagle, pers. comm.). Evaluating duckling mortality in North Dakota, Talent et al. (1983) found that predation by mink typically occurred in semipermanent wetlands. Based on a lower rate of predation and less mink sign associated with seasonal wetlands, they believed that semipermanent wetlands provided more suitable mink habitat than did less permanent wetland types.

Wetlands with irregular and diverse shorelines provide more suitable mink habitat than do wetlands with straight, open, exposed shorelines (Croxton 1960; Waller 1962; Gray and Arner 1977). Rapid declines in mink activity along Ontario lake shores were recorded where relatively small increases in human development had taken place (Racey and Euler 1983). The construction of cottages adjacent to lake shorelines typically resulted in reduced vegetative cover and diminished shoreline complexity due to the removal of snags, large rocks, aquatic vegetation, and the development of sand beaches. The decreased complexity of shoreline habitats was believed to reduce the amount of shelter available to crayfish resulting in decreased availability of mink prey.

Decreased diversity in shoreline configuration, elimination of aquatic vegetation, and decreased abundance and diversity of riparian vegetation caused by channelization reduced habitat quality, prey availability, and mink use of riverine habitats in Mississippi and Alabama (Gray and Arner 1977). Casson and Klimstra (1983) concluded that the abundance of suitable mink prey is reduced when shallow, detritus-rich, sloughs associated with meandering streams are replaced with an abrupt, monotypic, interface between aquatic and terrestrial cover types as a result of channelization. Habitats associated with small streams are preferred to those associated with large, broad rivers (Davis 1960). Mink are most common along streams where there is an abundance of downfall or debris for cover and pools for foraging. Log jams provide excellent foraging cover for mink because they provide shelter for aquatic organisms and security for mink (Melquist et al. 1981). Burgess (1978) recorded a 52.5% increase in mink activity along a stream reach in Quebec that had undergone habitat improvement. Stream alterations consisted of the creation of pools up to 1 m deep in 50% of the stream channel and the placement of logs and other cover within the channel. Dunstone and O'Connor (1979) attributed the mink's use of stream and lake edges to the inability of mink to efficiently forage in open water. Cover associated with aquatic ecotones allowed a stealthier approach and development of specific search strategies by mink (Dunstone 1978). Open water was believed to provide potentially suitable foraging areas only during periods of reduced water volume or high fish density. Shallow water depth and low flow rates contribute to effective aquatic foraging by mink (Dunstone 1983). Smith and McDaniel (1982) recorded greater use of fish by mink in Arkansas during drought, which tended to concentrate prey as a result of decreasing water levels.

The availability of suitable dens may limit the ability of a habitat to support mink (Errington 1961; Gerell 1970; Northcott et al. 1974; Birks and Linn 1982). The absence of dry den sites may limit the mink's use of some wetlands (Linn, pers. comm.). Mink typically select den sites that are close to preferred foraging areas or concentrations of prey items (Linn and Birks 1981; Melquist et al. 1981; Birks and Linn 1982). Mink use several dens within their home range for concealment, shelter, and litter rearing (Marshall 1936; Schladweiler and Storm 1969; Gerell 1970; Eberhardt 1973; Eberhardt and Sargeant 1977; Linn and Birks 1981; Melquist et al. 1981; Birks and Linn 1982). Maximum consecutive days of occupation of single dens in North Dakota was approximately 40 days (Eberhardt and Sargeant 1977). After kits became more mature, individual dens were used briefly and irregularly. The majority of den stays in England were less than 1 day in duration (Birks and Linn 1982). The mean distance covered for 12 den moves in North Dakota was 234 m (Eberhardt and Sargeant 1977). The mean distance between dens used for two or more consecutive days in Sweden was 544 m (Gerell 1970). The mean interden distance recorded in England was 492 m (Birks and Linn 1982). Movements of male mink to new den sites tended to be greater than those recorded for females. New mink dens in Wisconsin were usually within 90 m of the previous den site (Schladweiler and Storm 1969).

The majority of interden movements are made at night and typically occur in, or along, linear habitat features, such as lake shores, river banks, stream courses, or hedge-rows (Birks and Linn 1982). Gerell (1970) reported that the most "commonly" used dens were located in cavities beneath tree roots at the water's edge. However, "more preferred," but less common, den sites were within cavities or piles of rocks well above the water line. Birks and Linn (1982) also identified cavities within, or beneath, waterside trees as being an important source of den sites for mink. More than 50% of den sites of mink inhabiting coastal habitats in Scotland were situated in rock scree and outcrops (Dunstone and Birks 1983). Slightly more than 87% of all dens located were <50 m from the high water mark of normal spring tides.

Mink dens adjacent to lake shorelines in Ontario were located in sites with higher than average numbers of deadfalls and stumps and greater shrub and tree stem densities (Racey and Euler 1983). Log jams accounted for 53% of the mink dens located in Idaho (Melquist et al. 1981). Fallen branches, brush, and other debris provided additional den sites. The use of log jams increased during December, probably as a result of decreased accessibility to other den sites due to increasing snow depth. All mink dens located in North Dakota were situated on marsh shorelines and appeared to be in abandoned or seldom used muskrat burrows (Eberhardt 1973; Sargeant et al. 1973; Eberhardt and Sargeant 1977). The availability of dens for mink use was believed to be related to the suitability of the wetland for muskrats and the amount of shoreline grazing by livestock. Active mink dens were not located on heavily grazed shorelines. Errington (1954) characterized prime mink habitat in the north-central region of the United States as being choice muskrat habitat. Extremely high mink harvests have occurred in association with high muskrat populations in Louisiana (Linscombe and Kinler, pers. comm.). The highest densities of muskrats in Louisiana occur in association with bulrush (*Scirpus olneyi*).

Reproduction

No information relating specifically to habitat needs for reproduction was found in the available literature.

Interspersion

The home ranges of mink tend to approximate the shape of the water body along which they live (Gerell 1970; Linn and Birks 1981). A mink's use of its home range varies in intensity due to varying prey availability. During daily activity periods, mink move back and forth in a restricted "core area," which typically does not exceed 300 m in shoreline length (Gerell 1970). Eventually, the mink will use another den within the home range as a base and will intensively forage within an associated core area. Linn and Birks (1981) found that the mink's home range in England typically contained one or two core areas that were associated with prey concentrations. Although core areas generally occupied a small proportion (mean = 9.3%) of the home range area, mink spent approximately 50% of their time within these areas (Birks and Linn 1982). When prey was abundant throughout the home range, the core areas were not as well defined. When the aquatic aspect of the habitat was nonlinear (e.g., marshes), the home range was smaller and less linear in shape.

The mink's use of its home range also shows variation in response to seasonal differences in prey availability (Birks and Linn 1982). Movements recorded in England indicated a general reduction in activity in winter relative to summer. Fewer den sites were used, occupancy at individual dens was of longer duration, and daily travel distances were shorter. Mink home range size in British Columbia was believed to be inversely related to the quality of forage areas (Hatler 1976). The overall mink population was believed to be limited by the number of high quality, year-long foraging areas. Harbo (1958, cited by Pendleton 1982) attributed higher mink populations and smaller activity areas along coastal Alaska to a relatively consistent year-round food supply in the intertidal zone. The smaller home range size of mink inhabiting coastal areas, in comparison to mink associated with inland freshwater habitats, may be a consequence of prey concentrations in tidal pools and the regular replenishment of prey as a result of the tidal cycle (Dunstone and Birks 1983). Over 68% of the observations of active mink were recorded in and within a 100 m band shoreward of the littoral zone.

Vegetative cover had a significant impact on mink home range size in Montana (Mitchell 1961). The home range size for female mink within a heavily vegetated area was estimated to be 7.7 ha, while the home range of a female within a sparsely vegetated, heavily grazed area was 20.1 ha. Female mink home ranges in Michigan did not exceed 8 ha (Marshall 1936). Mink in Idaho were believed to be able to sustain themselves in a 1 to 2 km section of stream length (Melquist et al. 1981). Mink population densities along the coast of Vancouver Island, British Columbia, ranged from 1.5 to more than 3 animals/km of shoreline (Hatler 1976). Mink home range size in the prairie pothole region of North Dakota ranged from 2.59 km^2 to 3.8 km^2 and typically included numerous wetlands (Eagle, pers. comm.).

Female mink have the smallest and most well defined home ranges, while those of males tend to be more extensive and less well defined (Marshall 1936). The home range size for female mink in England was, on an average, 85.4% of a male's home range size (Birks and Linn 1982). Intrasexual and intersexual home range overlap was rare in a North Dakota study except during the 2- to 3-week breeding season in April (Eagle, pers. comm.). Female mink in Sweden were found to be more restricted to riparian habitats, while males transiently exploited upland areas (Gerell 1970). Male mink in England tended to forage away from aquatic habitats, while females typically remained near water (Birks and Linn 1982). Mink concentrating on aquatic prey tended to utilize larger core areas than individuals exploiting terrestrial prey species. Solely terrestrial foraging was exclusively a male activity and typically occurred where aquatic prey and prey associated with riparian habitats were scarce.

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This HSI model has been developed for application within inland wetland habitats throughout the range of the species. Figure 1 displays the approximate geographic distribution of mink in North America.

Season. This HSI model was developed to evaluate the potential quality of year-round habitat for the mink.

Cover types. This model was developed to evaluate the quality of mink habitat in the following wetland cover types (terminology follows that of Cowardin et al. 1979): Riverine (R), Lacustrine (L), and Palustrine Forested (PFO), Palustrine Scrub/Shrub (PSS), and Palustrine Emergent (PEM) wetlands.

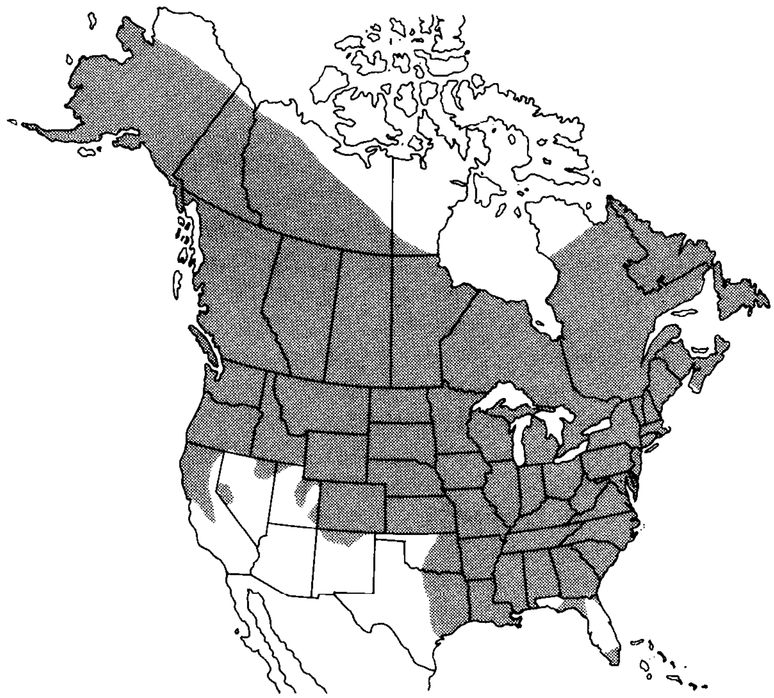


Figure 1. Approximate distribution of the mink in North America (adapted from Linscombe et al. 1982).

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous habitat that is required before an area will be occupied by a species. Information on the minimum habitat area for the mink was not found in the literature. The size and shape of mink home ranges vary in response to topography, food availability, and sex. Although home ranges of female mink are smaller than those of males, home ranges of both sexes tend to parallel the configuration of a body of water or wetland basin. Based on this information, it is assumed that any wetland, or wetland associated habitat, large enough to be identified and evaluated as such, has the potential to support mink.

Verification level. This HSI model provides habitat information useful for impact assessment and habitat management. The model is a hypothesis of species-habitat relationships and does not reflect proven cause and effect relationships. Earlier drafts of this model were reviewed by the following individuals:

Dr. Johnny Birks, University of Durham, Durham, Great Britain.
Dr. Paul Chanin, University of Exeter, Devon, Great Britain.
Dr. Thomas Eagle, University of Minnesota, Minneapolis.
Mr. John Hunt, Maine Department of Inland Fisheries and Wildlife, Augusta.
Mr. Noel Kinler, Louisiana Department of Wildlife and Fisheries, New Iberia.
Mr. Ian Linn, University of Exeter, Hatherly Laboratories, Exeter, Great Britain.
Mr. Greg Linscombe, Louisiana Department of Wildlife and Fisheries, New Iberia.
Mr. John Major, Maine Cooperative Wildlife Research Unit, University of Maine, Orono.
Mr. Barry Saunders, Ministry of Environment, British Columbia, Canada.

Improvements and modifications suggested by these individuals have been incorporated into this model.

Model Description

Overview. The year-round habitat requirements of mink can be satisfied within wetland cover types if sufficient vegetation or cover is present to support an adequate prey base. Although not totally restricted to wetland or wetland-associated cover types, the mink usually is dependent on aquatic organisms as a food source for a large portion of the year. Transient use of upland cover types may occur, particularly during the fall and winter months, when terrestrial prey plays an increasingly important role in the mink's diet. The majority of mink activity (foraging, establishment of dens, and litter rearing) occurs in close proximity to open water. This model assumes that sufficient cover must be interspersed with, or adjacent to, relatively permanent surface water in order to provide the maximum number and diversity of prey species. It is assumed in this model that potential food availability and cover for the mink can be described by the same set of habitat characteristics. The reproductive habitat requirements of the mink are assumed to be identical to its cover requirements.

The following sections provide documentation of the logic and assumptions used to translate habitat information for the mink to the variables and equations used in the HSI model. Specifically, these sections identify important habitat variables, define and justify the suitability levels of each variable, and describe assumed relationships between variables.

Water component. Mink are not totally dependent on aquatic or wetland-associated prey species. However, these species typically form the largest portion of the annual diet. It is assumed that surface water must be present for a minimum of 9 months of the year to provide optimum foraging habitat and prey availability for mink (Figure 2). Cover types with less permanent surface water are assumed to be indicative of less suitable mink habitat as a result of lower prey diversity and availability when considered on an annual basis. Wetland cover types consisting only of saturated soils, or lacking surface water, are assumed to be of no value as year-round mink habitat, due to the assumed absence of an adequate aquatic prey base.

The value calculated using Figure 2 is used in equation 1 to represent the water suitability index (SIW) for mink.

$$SIW = SIV1 \tag{1}$$

Equation 1 and the relationships between the permanence of surface water (SIV1) and habitat quality for mink are based on the following assumptions. Cover types that have surface water present <25% of the year are assumed to be unsuitable year-round mink habitat due to the absence of aquatic prey species. Abundance and availability of aquatic prey are assumed to increase as the permanence of surface water increases. Cover types that maintain surface water for >75% of the year are assumed to provide conditions conducive to maximum availability of aquatic prey.

Several reviewers of this model have commented that eutrophic lakes have greater potential productivity than do oligotrophic lakes. Eutrophic lakes may be capable of supporting larger populations of mink due to a more diverse and abundant aquatic prey base. The primary productivity of a lake depends in part upon the nutrients received from the surrounding drainage, geological age, and water depth. Oligotrophic lakes are typically deep, with the hypolimnion larger than the epilimnion, littoral zone vegetation is scarce and organic content and plankton density are low. In contrast, eutrophic lakes are typically shallow and have high concentrations of plant nutrients (e.g., nitrogen, phosphorus), high organic content, and abundant littoral zone vegetation. Although this model does not take into account a specific evaluation of a lake's potential ability to produce food organisms, it should be realized that a lake's ability to provide abundant aquatic prey for mink may vary based on its' physical and chemical characteristics.

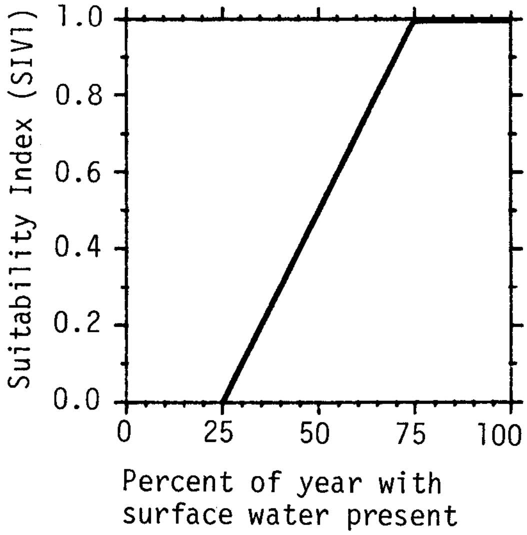


Figure 2. The relationship between percent of the year with surface water present and a suitability index of mink habitat quality.

Cover component. Although mink will use upland cover types, they are most often found in close association with wetlands and the vegetative communities immediately adjacent to streams, rivers, and lakes. Small terrestrial mammals become an important component of the mink's diet during the fall and winter months. Terrestrial mammals may be an important component in the diet of male mink throughout the year. Sufficient vegetative cover interspersed with, or immediately adjacent to, water is assumed to provide an adequate source of prey species to supplement the aquatic portion of the mink's diet. Dense woody cover of trees and shrubs provides the mink with potential den sites, escape cover, and foraging cover. Persistent herbaceous vegetation also may provide mink with sufficient cover for foraging and shelter. It is assumed that nonpersistent herbaceous vegetation, by itself, will not provide sufficient cover for mink during winter.

a. Palustrine forested and scrub/shrub wetlands. Suitable cover conditions for mink within forested and scrub/shrub wetlands are assumed to be a function of the total canopy closure of trees (Figure 3a), shrubs (Figure 3b), and emergent herbaceous vegetation (Figure 3c). Optimum conditions for cover, denning, and foraging are assumed to occur when the combined canopy cover of woody or persistent herbaceous vegetation is ≥75%. Forested or scrub/shrub wetlands with lower vegetative canopy closures are assumed to be less suitable mink habitat as a result of lower cover availability for both mink and their prey. Woody vegetation ≤100 m from a wetland's edge also is assumed to

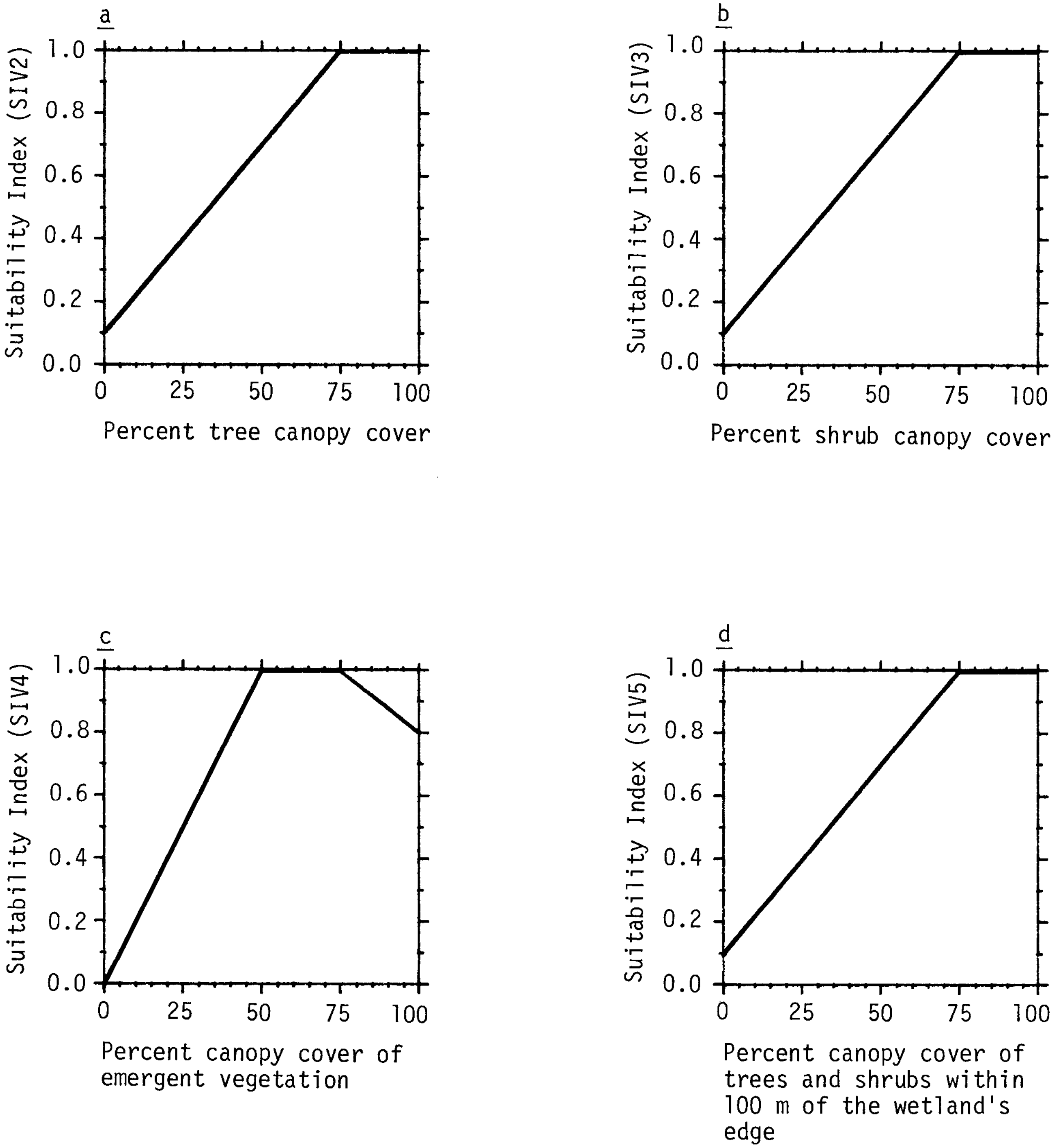


Figure 3. The relationships between tree, shrub, and emergent herbaceous vegetation canopy closure and suitability indices of mink habitat quality.

influence mink habitat quality. However, the degree to which vegetative cover in a 100 m band surrounding forested or scrub/shrub wetlands influences habitat quality for mink depends on the size of the wetland basin. In small forested or scrub/shrub wetlands the adjacent upland cover is assumed to play a relatively important role in defining overall habitat quality for the species. In contrast, the majority of mink inhabiting large, expansive forested or shrub wetlands probably are not influenced to a great degree by the quality of adjacent upland cover types.

In large forested or scrub/shrub wetlands cover quality for mink is assumed to be a function only of the amount of woody and emergent herbaceous vegetation present within the wetland basin. In small, or linear, forested and scrub/shrub wetlands cover quality is assumed to be a function of the canopy cover of woody and emergent herbaceous vegetation in the wetland basin and the canopy cover of woody vegetation in a 100 m band adjacent to the wetland (Figure 3d). Trees and shrubs adjacent to a wetland are believed to enhance the value of the wetland basin by providing cover for prey species and foraging cover for mink. Downfall and debris provided by woody vegetation also provides den sites in close association with the wetland cover type. Ideal conditions are assumed to occur when the canopy cover of trees or shrubs is ≥75%. Lower density of trees and shrubs is assumed to be indicative of less suitable cover conditions. However, the complete absence of woody cover adjacent to forested and scrub/shrub wetlands will not indicate totally unsuitable conditions since herbaceous vegetation, rocks, and other nonvegetative features may provide for mink and their prey.

For the purposes of this model large wetland basins are assumed to be ≥405 ha (1,000 acres). However, this is an arbitrary figure used to separate small and large wetlands for application of the model. Users may wish to redefine this value based on experience with regional cover type classifications.

The suitability index values from Figure 3 are used in equation 2 to determine a cover index (SIFS1) for mink in palustrine forested and scrub/shrub wetlands ≥405 ha. Equation 3 is intended for determination of a cover index for forested and scrub/shrub wetlands <405 ha.

$$SIFS1 = MIN(1.0;\ SIV2 + SIV3 + SIV4) \qquad (2)$$

$$SIFS2 = \frac{MIN(1.0;\ SIV2 + SVI3 + SIV4) + SIV5}{2} \qquad (3)$$

Equations 2 and 3 are based on the following assumptions. The suitability of canopy cover of trees (SIV2), shrubs (SIV3), and emergent vegetation (SIV4) are assumed to have equal weight in defining cover quality within forested and scrub/shrub wetlands. Ideal cover conditions may be provided by ≥75% canopy cover of trees, ≥75% canopy cover of shrubs, or 50% to 75% canopy cover of herbaceous vegetation. A combined canopy cover of trees shrubs, and emergent herbaceous vegetation also is assumed to be indicative of ideal cover conditions when total density is ≥75%. In situations where the sum of index values for SIV2, SIV3, and SIV4 is >1.0 the value used in the equation is 1.0.

Within forested and scrub/shrub wetlands <405 ha, the density of trees and shrubs <100 m from the wetland's edge (SIV5) is assumed to have equal influence in defining cover quality as does the density of vegetation within the wetland basin. Forested and scrub/shrub wetlands lacking woody cover adjacent to the basin reflect lower cover quality for mink, regardless of vegetative cover within the basin, than do wetlands surrounded by dense woody vegetation.

b. Palustrine emergent wetlands. Suitable cover for mink in palustrine emergent wetlands is assumed to be a function of the amount of the wetland basin supporting emergent herbaceous vegetation (Figure 3c) and, to a lesser extent, the amount of woody cover immediately adjacent to the wetland basin (Figure 3d). Ideal cover conditions are assumed to occur when the wetland basin supports 50% to 75% canopy cover of emergent herbaceous vegetation. Emergent wetlands with <50% canopy cover of emergent vegetation are assumed to be indicative of less suitable habitat as a result of lower cover availability for mink and prey species. Wetlands totally devoid of vegetation are assumed to have minimum value as year-round mink habitat due to the absence of suitable cover in the wetland basin. The cover value for mink in palustrine emergent wetlands may be enhanced if woody vegetation (trees and shrubs) is present within 100 m of the wetland's edge. Tree and shrub cover adjacent to the wetland basin is assumed to enhance prey diversity and increase cover and den sites for mink.

The suitability index value from Figures 3c and 3d are used in equation 4 to determine a cover index (SIPE) for palustrine emergent wetlands.

$$\text{SIPE} = \frac{4\text{SIV4} + \text{SIV5}}{5} \qquad (4)$$

Equation 4 is based on the following assumptions. The abundance of emergent herbaceous vegetation (SIV4) is assumed to be the major characteristic defining the quality of cover for mink in palustrine emergent wetlands, and has been weighted in the equation to reflect this assumption. Wetlands surrounded, or bordered, by trees and shrubs will reflect higher cover quality than will wetlands with equivalent amounts of emergent vegetation but lacking adjacent woody cover. Conversely, palustrine emergent wetlands with little to no emergent vegetation are assumed to be indicative of cover conditions of low quality regardless of the amount of woody cover adjacent to the wetland basin.

c. Riverine and lacustrine wetlands. Within riverine and lacustrine cover types, suitable cover for mink is assumed to be related to the density of woody vegetation within 100 m of the water's edge and the availability of foraging and security cover at the land/water interface. Ideal cover conditions are assumed to exist when tree canopy cover and shrub canopy cover either singly or in combination account for ≥75% canopy cover (Figure 3d). Less dense vegetative cover adjacent to lakes and river or stream channels characterize less suitable cover conditions for mink as a result of decreased foraging cover, den sites, and cover for prey species. Riverine and lacustrine wetlands lacking adjacent woody vegetation are assumed to have low value as mink habitat due to the absence of cover for both mink and their terrestrial prey.

Mink foraging activity in riverine and lacustrine cover types is concentrated along the shoreline or land/water interface as compared to palustrine forested or emergent wetlands, where foraging activity may occur throughout the wetland basin. Therefore, the amount of cover or vegetative and structural diversity along shorelines has a major influence on the definition of habitat quality for mink inhabiting these cover types. Shorelines with a high degree of cover, which may be provided by overhanging or emergent vegetation, exposed roots, debris, log jams, undercut banks, boulders, or rock crevices, provide cover for prey species as well as secure foraging cover for mink. Conversely, shorelines that are straight, open, exposed, have little structural cover, and have an abrupt, monotypic edge between water and land provide virtually no cover for mink or their prey. It is assumed that ideal cover for mink is present where 100% of the shoreline provides dense foraging and security cover (Figure 4). As the amount of shoreline cover decreases cover quality for mink in riverine and lacustrine cover types is assumed to diminish. Shorelines devoid of vegetative or structural cover are assumed to have extremely low value as mink habitat, as a result of decreased prey availability and less than ideal foraging conditions.

The suitability index values from Figure 3d and Figure 4 are used in equation 5 to determine a cover index (SIRL) for riverine and lacustrine cover types.

$$SIRL = (SIV5 \times SIV6)^{1/2} \quad (5)$$

Equation 5 is based on the following assumptions. The suitability of the abundance of woody vegetation within 100 m of the water's edge (SIV5) and the suitability of the percentage of the shoreline with suitable cover (SIV6) are assumed to have equal value in defining cover quality for mink in riverine and lacustrine cover types. These variables are assumed to be compensatory in that a low value for one variable may be offset by a higher value for the remaining variable. Optimum conditions in terms of cover for prey species and mink foraging will be obtained only when the tree and shrub canopy cover within 100 m of the water's edge is ≥75%, and 100% of the shoreline provides cover within 1 m of the water's edge. Lower values for either variable will result in a SIRL of <1.0.

<u>HSI determination</u>. The calculation of an HSI for the mink considers life requisite values for water and cover. The HSI is equal to the lowest value calculated for either life requisite.

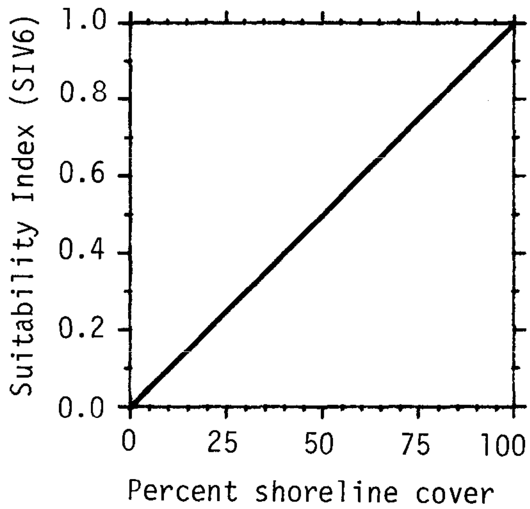


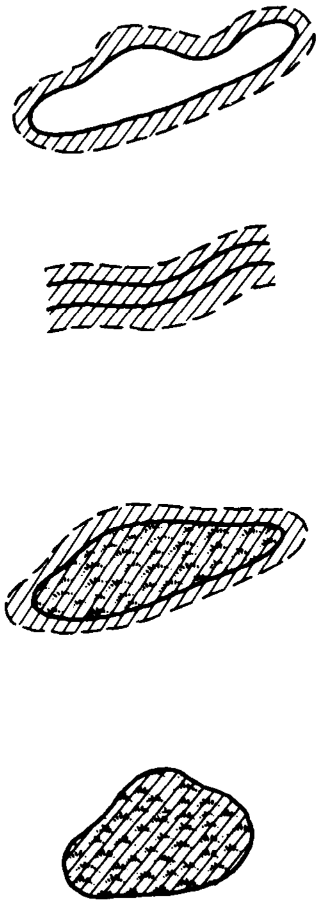
Figure 4. The relationship between shoreline cover and the suitability index for mink cover quality in riverine and lacustrine cover types.

Application of the Model

Delineation of cover types. Potential mink habitat must contain a relatively permanent source of surface water. Because of the mink's use of upland cover types for denning and foraging, optimum habitat must also support suitable cover adjacent to the water body or wetland. Therefore, application of this model and determination of Habitat Units (U.S. Fish and Wildlife Service 1980) is based on an evaluation of the quality of the wetland cover type and a 100 m band surrounding the wetland. Figure 5 illustrates the relationship of wetland cover types and suggested evaluation area.

Summary of model variables. Six habitat variables are used in this model to evaluate water and cover conditions for mink. Not all variables are used to evaluate each cover type. The relationships between habitat variables, cover types, life requisite values, and HSI are summarized in Figure 6. Definitions and suggested measurement techniques (Hays et al. 1981) for the variables used in the mink HSI model are provided in Figure 7.

Cover type | Area for evaluation



Lacustrine

HSI determined only for area contained within 100 m (328 ft) band around lake.

Riverine

HSI determined for area within 100 m band on both sides of river plus area of river.

Palustrine [emergent wetlands forested wetlands, or scrub/shrub wetlands less than 405 ha (1,000 acres) in size].

HSI determined for area contained within cover type plus area within 100 m band around wetland cover type.

Palustrine [forested wetlands or shrub wetlands ≥405 ha (1,000 acres) in size]

HSI determined for area contained only within cover type.

Figure 5. Guidelines for determining the area to be evaluated for mink habitat suitability in various wetland cover types.

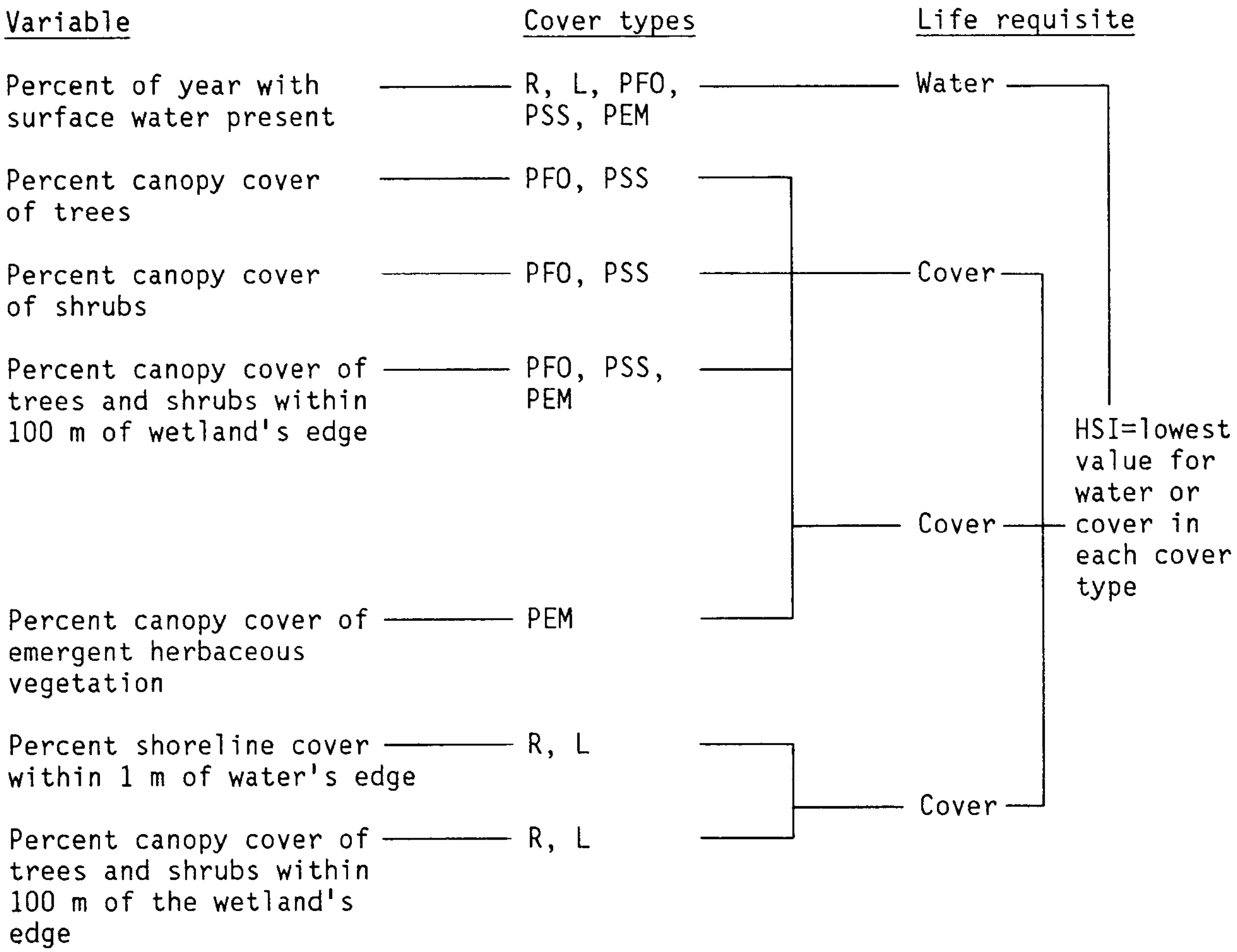


Figure 6. Relationships of habitat variables, cover types, life requisite values, and HSI in the mink HSI model.

Variables (definition)	Cover types	Suggested technique
Percent of year with surface water present (the percent of the year in which wetland cover types have surface water present).	R, L, PFO PSS, PEM	On site inspection, historical records
Percent canopy cover of trees [the percent of the ground surface that is shaded by a vertical projection of the canopies of all woody vegetation ≥6 m (20 ft) tall].	PFO, PSS	Line intercept, quadrat, remote sensing
Percent canopy cover of shrubs [the percent of the ground surface that is shaded by a vertical projection of the canopies of woody vegetation <6 m (20 ft) tall].	PFO, PSS	Line intercept, quadrat, remote sensing
Percent canopy cover of emergent herbaceous vegetation (the percent of the water surface shaded by a vertical projection of the canopies of emergent herbaceous vegetation, both persistent and nonpersistent).	PFO, PSS PEM	Line intercept, quadrat, remote sensing
Percent canopy cover of trees and shrubs within 100 m (328 ft) of the wetlands edge [the percent of the terrestrial ground surface within 100 m (328 ft) of a wetland's edge that is shaded by a vertical projection of the canopies of all woody vegetation].	PFO <405 ha PSS <405 ha PEM, R,L	Line intercept, quadrat, remote sensing
Percent shoreline cover within 1 m (3.3 ft) of water's edge [An estimate of the vegetative and structural complexity at the land/water interface (≤1 m from water's edge). Cover may be provided by overhanging or emergent vegetation, undercut banks, logjams, debris, exposed roots, boulders or rock crevices].	R, L	On-site inspection, line intercept, quadrat

Figure 7. Definitions of variables and suggested measurement techniques.

Model assumptions. The mink HSI model is based on the following key assumptions.

1. Mink habitat use is centered around wetland cover types. Surface water must be present for a minimum of 9 months per year to provide optimum habitat conditions.

2. Cover furnished by vegetation and structural diversity provides shelter and habitat for prey species as well as foraging and security cover for mink. Relatively dense vegetative cover must be present within wetlands and adjacent upland cover types in order to provide maximum prey diversity, foraging opportunities, and cover for mink. The density of woody vegetation in upland cover types is assumed to have no influence on mink habitat quality in extensive (≥405 ha) forested and scrub/shrub wetlands.

3. The availability of surface water and cover are assumed to indirectly address the availability of suitable mink prey and to directly address cover quality for mink.

SOURCES OF OTHER MODELS

No other habitat models for mink were located in the literature.

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16. Abstract (Limit: 200 words)

A review and synthesis of existing information were used to develop a Habitat Suitability Index (HSI) model for the mink (*Mustela vison*). The model consolidates habitat use information into a framework appropriate for field application, and is scaled to produce an index between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). HSI models are designed to be used with Habitat Evaluation Procedures previously developed by U.S. Fish and Wildlife Service.

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