Supplementary materials

Supplementary Table

Table S1. Sampling locations.

Species	Longitude	Latitude
Gentiana_rhodantha	100.3125	25.22917
Gentiana_rhodantha	100.3125	25.6875
Gentiana_rhodantha	100.3542	25.02083
Gentiana_rhodantha	100.6875	24.89583
Gentiana_rhodantha	102.2292	29.9375
Gentiana_rhodantha	102.4792	27.47917
Gentiana_rhodantha	102.6042	26.64583
Gentiana_rhodantha	102.6458	24.97917
Gentiana_rhodantha	102.7292	34.10417
Gentiana_rhodantha	102.8125	27.14583
Gentiana_rhodantha	102.8125	30.35417
Gentiana_rhodantha	102.9792	26.3125
Gentiana_rhodantha	103.0208	25.39583
Gentiana_rhodantha	103.0625	27.10417
Gentiana_rhodantha	103.1042	27.22917
Gentiana_rhodantha	103.1458	23.35417
Gentiana_rhodantha	103.3542	23.39583
Gentiana_rhodantha	103.9375	30.60417
Gentiana_rhodantha	103.9792	27.4375
Gentiana_rhodantha	104.1875	24.0625
Gentiana_rhodantha	104.2292	23.39583
Gentiana_rhodantha	104.2708	26.89583
Gentiana_rhodantha	104.3125	23.02083
Gentiana_rhodantha	104.3125	23.10417
Gentiana_rhodantha	104.3542	27.35417
Gentiana_rhodantha	104.3542	27.39583
Gentiana_rhodantha	104.4792	25.72917
Gentiana_rhodantha	104.5208	32.39583
Gentiana_rhodantha	104.6042	22.72917
Gentiana_rhodantha	104.6042	24.8125
Gentiana_rhodantha	104.7292	23.14583
Gentiana_rhodantha	104.7292	32.52083
Gentiana_rhodantha	104.8542	22.9375
Gentiana_rhodantha	105.1458	25.0625
Gentiana_rhodantha	105.1875	24.64583
Gentiana_rhodantha	105.2292	23.39583
Gentiana_rhodantha	105.2708	23.9375

Gentiana_rhodantha	105.3125	26.77083
Gentiana_rhodantha	105.3958	26.77083
Gentiana_rhodantha	105.3958	27.60417
Gentiana_rhodantha	105.5208	25.39583
Gentiana_rhodantha	105.5208	25.72917
Gentiana_rhodantha	105.5208	25.77083
Gentiana_rhodantha	105.5625	32.89583
Gentiana_rhodantha	105.6042	23.5625
Gentiana_rhodantha	105.6042	25.77083
Gentiana_rhodantha	105.6042	27.14583
Gentiana_rhodantha	105.6875	26.85417
Gentiana_rhodantha	105.6875	28.60417
Gentiana_rhodantha	105.7292	26.85417
Gentiana_rhodantha	105.7708	23.47917
Gentiana_rhodantha	105.7708	26.27083
Gentiana_rhodantha	105.9792	28.27083
Gentiana_rhodantha	106.0208	26.5625
Gentiana_rhodantha	106.0208	28.4375
Gentiana_rhodantha	106.1042	25.89583
Gentiana_rhodantha	106.2708	27.77083
Gentiana_rhodantha	106.3542	24.6875
Gentiana_rhodantha	106.3958	27.8125
Gentiana_rhodantha	106.3958	29.8125
Gentiana_rhodantha	106.4375	24.8125
Gentiana_rhodantha	106.6042	27.64583
Gentiana_rhodantha	106.6875	26.39583
Gentiana_rhodantha	106.7708	25.4375
Gentiana_rhodantha	106.8125	26.8125
Gentiana_rhodantha	106.9375	26.39583
Gentiana_rhodantha	106.9792	26.47917
Gentiana_rhodantha	107.0208	26.89583
Gentiana_rhodantha	107.1042	29.14583
Gentiana_rhodantha	107.1875	27.9375
Gentiana_rhodantha	107.5515	25.41666
Gentiana_rhodantha	107.4792	27.4375
Gentiana_rhodantha	107.5208	28.3125
Gentiana_rhodantha	107.8125	24.27083
Gentiana_rhodantha	107.8542	25.85417
Gentiana_rhodantha	107.8958	25.97917
Gentiana_rhodantha	107.9792	26.5625
Gentiana_rhodantha	108.1458	27.14583
Gentiana_rhodantha	108.2292	28.27083
Gentiana_rhodantha	108.3542	28.14583
Gentiana_rhodantha	108.5208	27.64583

Gentiana_rhodantha	108.6875	27.89583
Gentiana_rhodantha	108.6875	31.9375
Gentiana_rhodantha	108.8958	34.14583
Gentiana_rhodantha	109.0208	31.8125
Gentiana_rhodantha	109.1042	27.64583
Gentiana_rhodantha	109.1042	33.6875
Gentiana_rhodantha	109.1875	27.60417
Gentiana_rhodantha	109.4375	26.52083
Gentiana_rhodantha	109.4792	28.5625
Gentiana_rhodantha	109.5208	28.5625
Gentiana_rhodantha	109.5625	31.39583
Gentiana_rhodantha	109.6042	27.9375
Gentiana_rhodantha	109.6458	28.6875
Gentiana_rhodantha	109.6875	28.4375
Gentiana_rhodantha	109.8542	28.97917
Gentiana_rhodantha	109.8958	31.0625
Gentiana_rhodantha	110.1458	28.97917
Gentiana_rhodantha	110.4375	33.47917
Gentiana_rhodantha	110.4792	28.6875
Gentiana_rhodantha	110.5208	33.60417
Gentiana_rhodantha	110.6042	30.1875
Gentiana_rhodantha	110.6042	33.4375
Gentiana_rhodantha	110.7292	33.35417
Gentiana_rhodantha	111.0208	27.10417
Gentiana_rhodantha	111.0625	30.1875
Gentiana_rhodantha	111.1042	26.5625
Gentiana_rhodantha	112.4375	35.1875
Gentiana_rhodantha	112.9792	28.10417
Gentiana_rhodantha	113.3958	35.47917
Gentiana_rhodantha	113.8125	35.47917
Gentiana_rhodantha	114.2292	31.14583
Gentiana_rhodantha	115.3542	29.4375
Gentiana_rhodantha	115.9792	40.47917
Gentiana_rhodantha	99.3125	29.4375
Gentiana_rhodantha	99.5625	23.5625
Gentiana_rhodantha	99.72917	24.22917

Table S2. Migration distances of cores for suitable habitats under different climate scenarios.

scenarios	Period		
	2041-2060	2061-2080	2081-2100
ssp126	101.29Km	122.76 Km	132.05 Km
ssp245	170.15 Km	182.59 Km	251.27 Km
ssp585	163.06 Km	178.07 Km	209.52 Km

Table S3. Niche overlap and range overlap of potential distribution areas of *G. rhodantha*.

Niche / Range	current	ssp126_2050	ssp245_2050	ssp585_2050	ssp585_2070	ssp126_2070	ssp245_2070	ssp585_2090	ssp126_2090	ssp245_2090
current	1	0.755351084	0.745192461	0.679771666	0.670940943	0.753641483	0.720074417	0.62883334	0.7564436	0.706165316
ssp126_2050	0.861160968	1	0.972761249	0.881087561	0.925569934	0.974252459	0.96002157	0.898053857	0.974020685	0.950733471
ssp245_2050	0.884844372	0.970595559642166	1	0.883750309	0.933811123	0.971286561	0.967375605	0.906645995	0.972348869	0.959278933
ssp585_2050	0.838681434	0.9536536	0.977033335	1	0.895689127	0.880435067	0.888440152	0.884353561	0.87682694	0.890535737
ssp585_2070	0.74451692	0.875811975	0.807305178	0.949756148	1	0.927285539	0.949854496	0.958117179	0.92539045	0.957287606
ssp126_2070	0.887164558	0.966591958	0.951019557	0.97255153	0.912192591	1	0.959693398	0.899692311	0.971927346	0.951976225
ssp245_2070	0.859169111	0.963948432	0.934459614	0.966086992	0.963681644	0.928162018	1	0.924998761	0.960784738	0.972348227
ssp585_2090	0.671850824	0.809019378	0.89628479	0.734587864	0.931297904	0.843039393	0.932953 07	1	0.897214821	0.933581756
ssp126_2090	0.902486539	0.985039174	0.954775015	0.991242926	0.953637024	0.975613992	0.914591255	0.903898551	1	0.950201274
ssp245_2090	0.799391498	0.904066816	0.891634824	0.899789335	0.959883781	0.876975718	0.941276694	0.923836928	0.900732801	1

Table S4. The niche breath of potential distribution areas of *G. rhodantha*.

Period	inverse concentration	uncertainty
current	0.038524922	0.84222557
ssp126_2050	0.046841396	0.859764172
ssp245_2050	0.044948273	0.856320849
ssp585_2050	0.036563824	0.843393243
ssp585_2070	0.05057087	0.863641997
ssp126_2070	0.046001062	0.858608528
ssp245_2070	0.045469927	0.857356017
ssp585_2090	0.055327114	0.869062773
ssp126_2090	0.045751322	0.857235521
ssp245_2090	0.047120412	0.859345135

Table S5. The distribution area of *G. rhodantha* in the middle and high suitable habitats ranks in the top 10 countries in the world.

Period		Class	China	Bhutan	Vietnam	India	Myanmar	Colombia	Nepal	South Korea	North Korea	Russia
Current		Class I area (Km^2)	673536	19136	26496	20928	21568	21568	896	1216	0	0
		Class II area (Km^2)	548864	5952	576	256	192	128	64	0	0	0
2041-2060	ssp126	Class I area (Km^2)	1151616	12544	19520	28736	39424	9344	192	36864	30208	2752
		Class II area (Km^2)	611776	14528	4032	2880	2752	704	0	0	0	0
	ssp245	Class I area (Km^2)	1535488	11520	9344	19264	37760	64	23168	50368	62272	5376
		Class II area (Km^2)	607040	15424	1152	4288	3456	0	1408	0	448	192
	ssp585	Class I area (Km^2)	1491328	11392	8384	20800	36864	64	26176	38528	47424	3392
		Class II area (Km^2)	591040	16448	320	5056	4928	0	2816	0	192	0
2061-2080	ssp126	Class I area (Km^2)	1370368	11904	11776	20416	39424	128	26432	35008	33088	704
		Class II area (Km^2)	696192	15872	1216	4032	2752	0	2880	0	128	0
	ssp245	Class I area (Km^2)	1710336	10304	7168	17664	34176	64	23552	52352	56448	2816
		Class II area (Km^2)	556864	16576	128	4544	5376	0	1088	0	256	0
	ssp585	Class I area (Km^2)	1464256	11776	3840	8512	24896	64	14656	27840	55424	12224
		Class II area (Km^2)	363136	13312	0	2112	1984	0	0	0	320	384
2081-2100	ssp126	Class I area (Km^2)	1408064	11136	10880	20352	37632	128	28736	53696	59200	7808
		Class II area (Km^2)	744960	17344	1152	5312	7808	0	3264	0	320	256
	ssp245	Class I area (Km^2)	1819712	11008	6016	13952	31680	64	21440	38464	57856	2304
		Class II area (Km^2)	392448	16448	64	2816	1856	0	768	0	192	0
	ssp585	Class I area (Km^2)	1384896	13312	1536	5952	19776	0	9600	26112	61632	18624
		Class II area (Km^2)	196096	8960	0	1152	832	0	0	0	192	1088

Table S6. The distribution area of *G. rhodantha* in the middle and high suitable growth areas ranks in the top 13 Province in the China.

Period			Sichuan	Guizhou	Yunnan	Chongqing	Xizang	Hubei	Guangxi	Shaanxi	Shandong	Gansu	Hunan	Jiangsu	Hebei
Current		Class I area (Km^2)	52225	46850	173375	7925	50475	156000	68500	69900	122100	17550	76000	101575	2400
		Class II area (Km^2)	293950	175325	114125	102400	35325	24475	23725	20950	5425	1950	775	550	150
2041-2060	ssp126	Class I area (Km^2)	82600	85575	168525	44150	57625	149000	36950	75475	167950	10150	0	73425	18800
		Class II area (Km^2)	245575	118825	41525	66175	19175	4000	2075	13225	2125	275	0	0	175
	ssp245	Class I area (Km^2)	64235.52	51701.76	138677.8	33269.76	37209.6	108218.9	36979.2	50641.92	98058.24	12280.32	54489.6	75248.64	24883.2
		Class II area (Km^2)	154967	101237.8	49996.8	36748.8	16266.24	8386.56	2165.76	14837.76	9423.36	852.48	0	161.28	46.08
	ssp585	Class I area (Km^2)	108350	72650	149375	54300	56000	46325	24425	56000	95400	13150	66625	84625	9000
		Class II area (Km^2)	144300	99925	31275	28400	24675	16025	700	24675	5700	1075	0	250	75

2061-2080	ssp126	Class I area (Km^2)	58950	66525	164750	32825	50225	102625	36025	54900	136050	6300	41150	65700	9525
		Class II area (Km^2)	193775	107575	45375	49875	15275	1550	3200	7825	8775	50	0	425	75
	ssp245	Class I area (Km^2)	119650	72475	173975	61375	49075	118825	19725	59575	129900	13925	46125	93400	11600
		Class II area (Km^2)	148625	95775	37475	21325	15650	1900	375	18300	2250	1375	0	300	75
	ssp585	Class I area (Km^2)	187750	94125	124100	72350	50875	84725	8600	63425	104725	18475	25800	47725	26375
		Class II area (Km^2)	65650	60850	20775	9625	8650	300	50	13925	5500	1800	0	0	75
2081-2100	ssp126	Class I area (Km^2)	55100	54425	163325	25475	48650	130150	37050	56475	128200	12675	41700	86150	7925
		Class II area (Km^2)	205200	120925	62925	57225	21550	6775	4225	17375	6300	2200	0	550	75
	ssp245	Class I area (Km^2)	163175	90200	166350	70575	52300	136300	14050	67050	135950	11850	27675	90750	35125

	Class II area (Km^2)	94225	74075	26450	11850	14125	400	75	10700	13000	125	0	550	75
ssp585	Class I area (Km^2)	188650	108150	101625	50225	59200	82700	1325	63875	80200	19300	9500	66950	5700
	Class II area (Km^2)	32975	24700	9750	2825	5725	0	0	11275	5475	1975	0	0	75

Table S7. Future area changes of *G. rhodantha* in China.

Period		Expansion (Km^2)	Loss (Km^2)	Expansion-Loss (Km^2)
2041-2061	ssp126	170397.7	106299	64098.74
	ssp245	298874	86123.98	212750
	ssp585	277710.5	98593.96	179116.6
2061-2081	ssp126	246358.2	84096.34	162261.8
	ssp245	366825.3	107186.1	259639.2
	ssp585	190167.2	198658	-8490.74
2081-2100	ssp126	310558.3	71601.01	238957.3
	ssp245	358841.4	156559.1	202282.4
	ssp585	186897.6	358385.2	-171488

Table S8. Niche overlap of potential distribution areas of *G. rhodantha*.

I D	current	ssp126_2050	ssp245_2050	ssp585_2050	ssp585_2070	ssp126_2070	ssp245_2070	ssp585_2090	ssp126_2090	ssp245_2090
current	1	0.70691428	0.698521604	0.706613933	0.61794129	0.703310226	0.674910416	0.554786622	0.704783168	0.650394302
ssp126_2050	0.915775	1	0.926381642	0.845703485	0.841037879	0.93596201	0.91003988	0.771612005	0.935778208	0.890393402
ssp245_2050	0.910139	0.993397335	1	0.851362508	0.860240836	0.927185418	0.929429492	0.791854696	0.932469322	0.90834289
ssp585_2050	0.904748	0.975684621	0.977022575	1	0.775627933	0.844436494	0.834653771	0.718493296	0.843382235	0.818753605
ssp585_2070	0.85443	0.975227142	0.98057399	0.959616736	1	0.841589066	0.88430328	0.892391161	0.845730709	0.907705416
ssp126_2070	0.913845	0.994350167	0.993243473	0.975976267	0.975794814	1	0.911411387	0.76934215	0.936918546	0.894697018
ssp245_2070	0.896575	0.991560958	0.993736814	0.97524282	0.986593962	0.991404062	1	0.818305294	0.919270183	0.933430694
ssp585_2090	0.805557	0.949236442	0.957715292	0.935412203	0.987919163	0.949344953	0.969199912	1	0.776198156	0.842911874
ssp126_2090	0.915417	0.994122498	0.993149113	0.974785527	0.975670384	0.99351131	0.991977575	0.950573061	1	0.895304058
ssp245_2090	0.881974	0.988326962	0.991419102	0.97212425	0.990661198	0.988691629	0.994654309	0.975653301	0.987972439	1

Note: D: Schoener's D; I: Hellinger distance. Schoener's D and Hellinger distance values representing niche overlap for all periods. Values closer to 1 indicate a high level of overlap, while low values indicate a low level of overlap.

Supplementary Figure

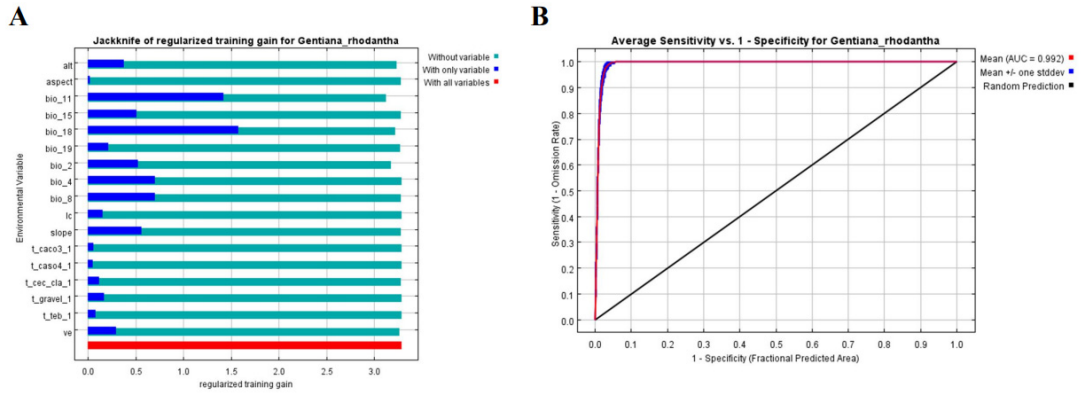
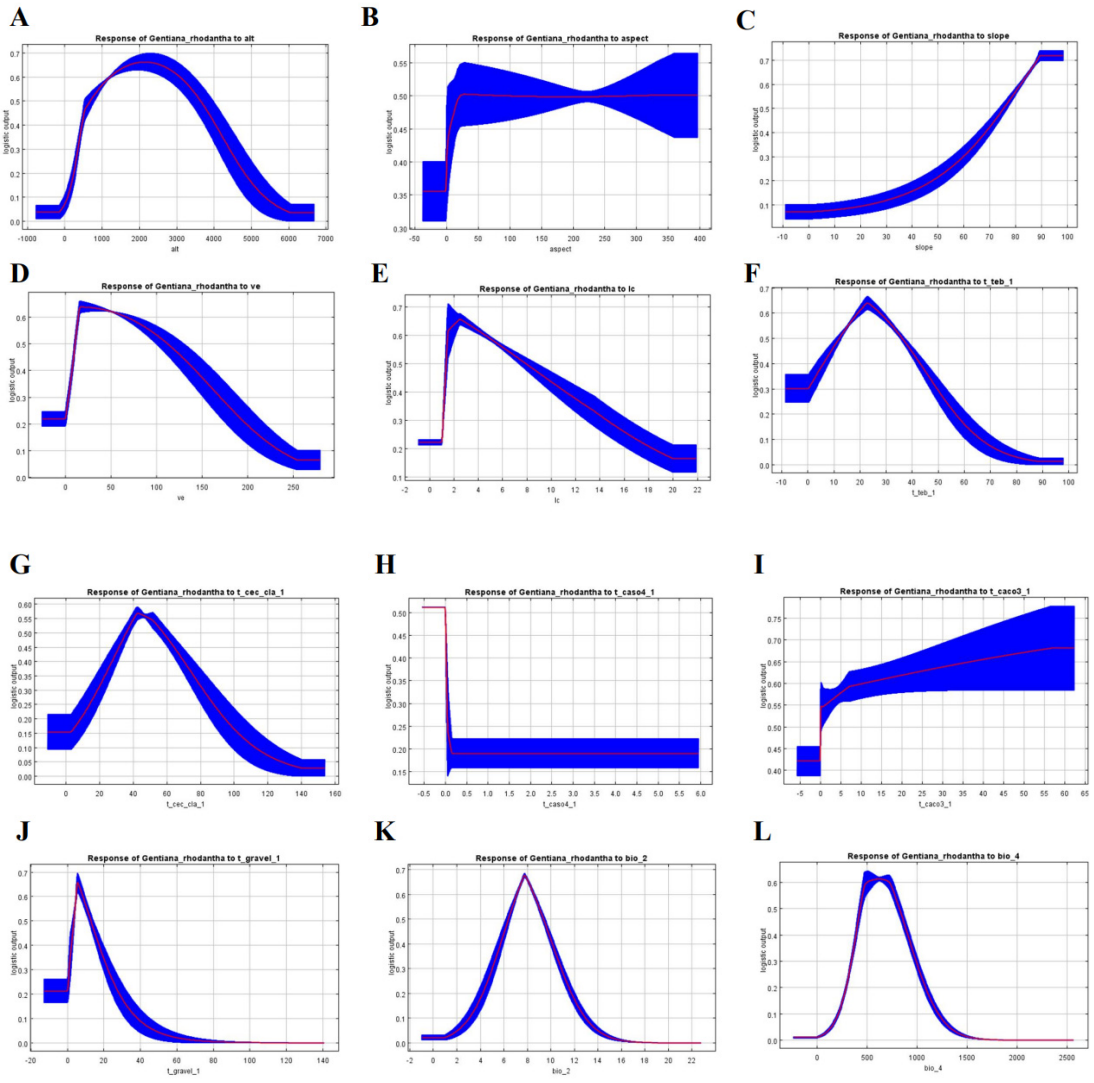


Figure S1. A. Represents the results of the jackknife test of variables' contribution in modeling *G. rhodantha* habitat suitability distribution. B. ROC curve and AUC value under the current period (10 replicated runs). The current period was from 1950 to 2000.



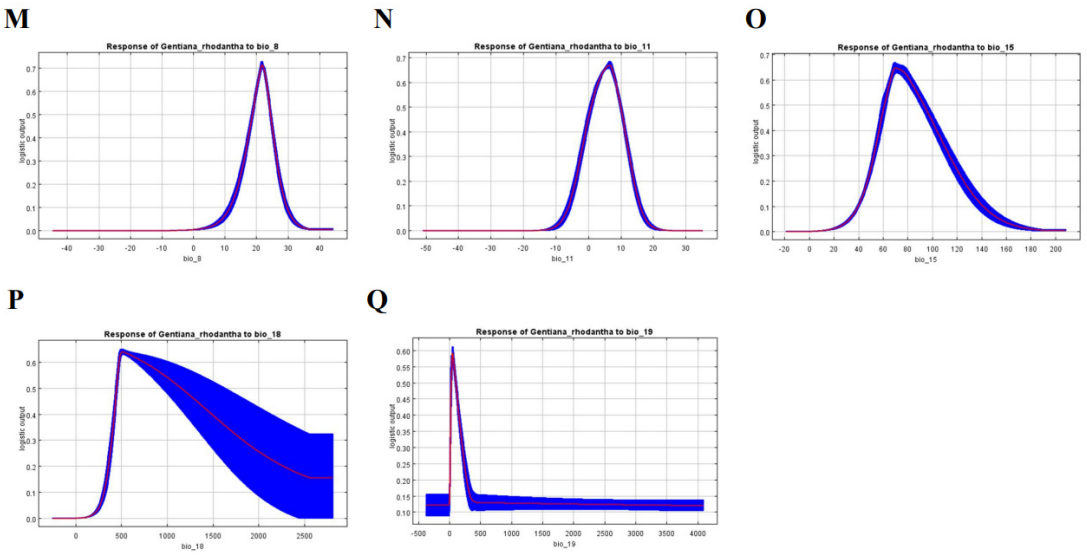


Figure S2. Response curves of 17environmental variables in *G. rhodantha* habitat distribution model.

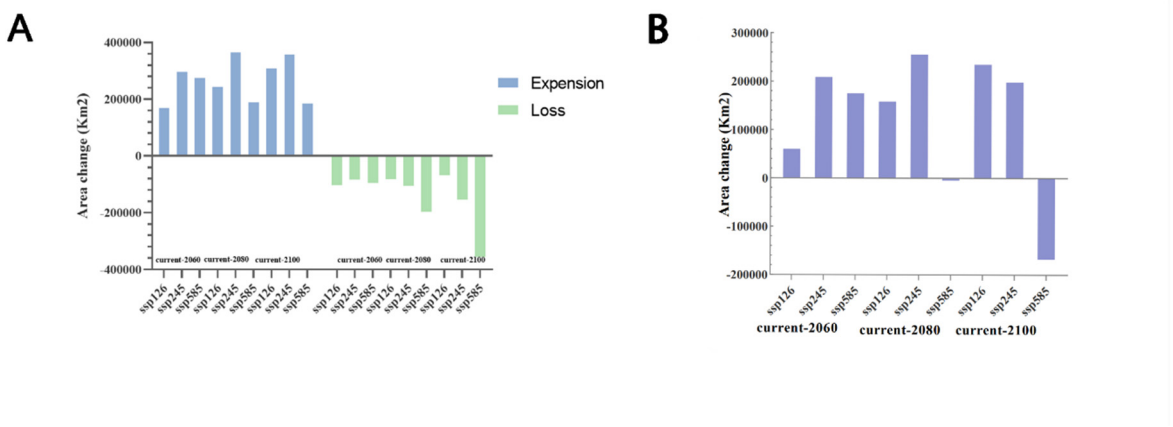


Figure S3. (A) Future area contraction and amplification of *G. rhodantha* in China; (B) Future trend of *G. rhodantha* in China (Expansion-Loss).



Figure S4. Trends of *G.rhodantha* in medium suitable habitats under different scenarios in the top 15 provinces of China.

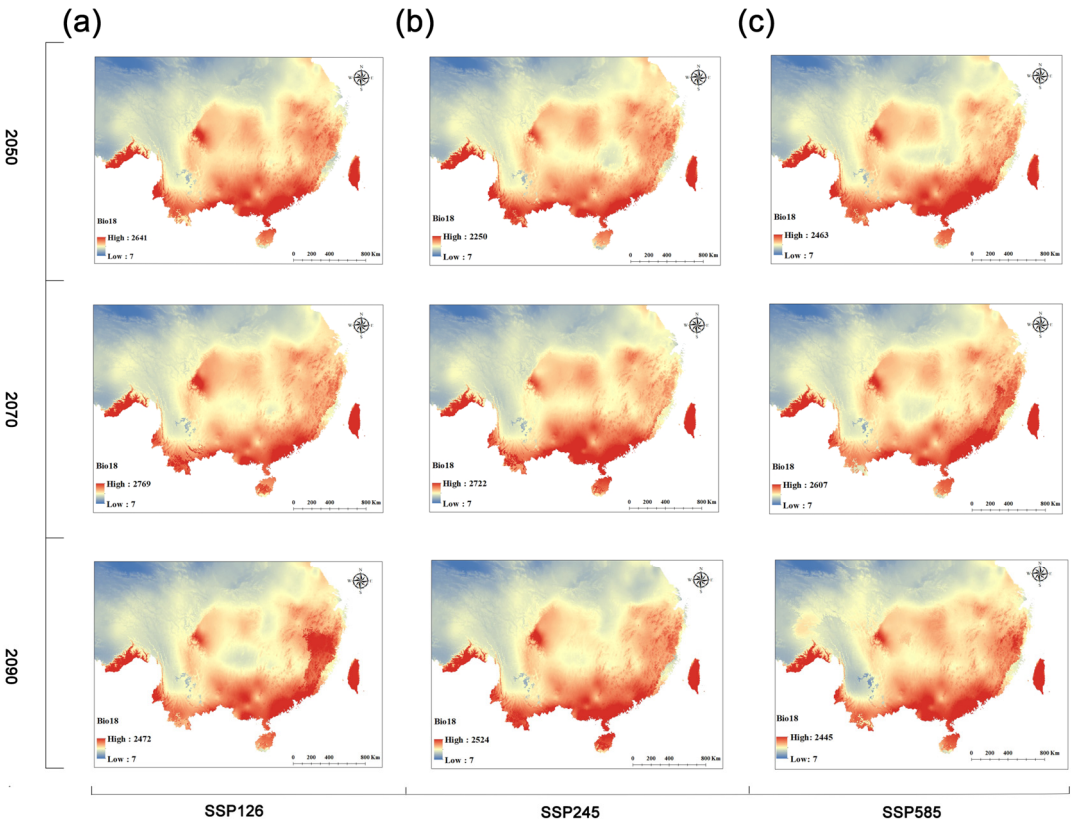


Figure S5. Changes in Bio18 of *G. rhodantha* in China under future climate scenarios. (A) Under SSP126 scenario in 2050s, 2070s and 2090s; (B) Under SSP245 scenario in 2050s, 2070s and 2090s; (C) Under SSP585 scenario in 2050s, 2070s and 2090s.

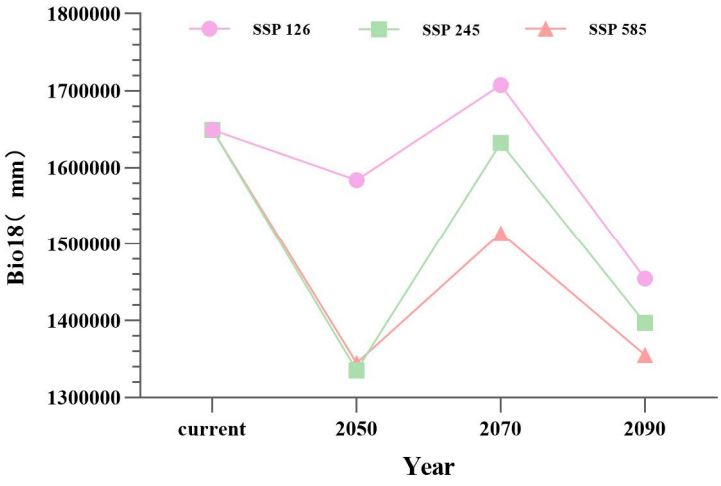


Figure S6. Changes in Bio18 over different periods.