

Appendix II. Detailed List of Potential FFESC Research Topics with a list of research projects that Address the Topic (Research Project Numbers are from Appendix I).												Research Projects with Major Focus on this Topic								Sum Major	% of Major	Projects that provide Minor information on this Topic								Sum Minor	% of Minor						
1 Mitigation = Increasing carbon sequestration and reducing greenhouse gas emissions from forest and rangelands and the forest and range sector																				20	14.3									14	15.7						
1.1 Landbased research -that directly contributes to models such as CBM-CFS3 (see Black et al. 2008)																				20	14.3									11	12.4						
1.1.1 Forest and rangeland carbon cycles across multiple scales and multiple forest types												12	31	34	66	100	118	119	15	10.7	17	58	59	60	61	62	154	8	9.0								
1.1.1.1 Micrometeorological studies in major forest types to provide better NEP and climate change sensitivity estimates for CBM-CFS3												3	7							2	1.4									0	0.0						
1.1.1.2 Remote sensing studies in major forest types to provide better NEP and climate change sensitivity estimates for CBM-CFS3												6	26							2	1.4									0	0.0						
1.1.1.3 Effect of interactions among fire suppression and forest insects & disease on carbon sequestration												43	116							2	1.4									0	0.0						
1.1.1.4 Effects of MPB and MPB salvage on carbon sequestration esp. effects of secondary structure to improve CBM-CFS3 estimates												35	98							2	1.4									0	0.0						
1.1.1.5 Effect of soil biological process such as mycorrhizal activity on soil carbon storage																		0	0.0	112									1	1.1							
1.1.2 Multi-scale analysis of forest management practices to enhance carbon storage												65							5	3.6									3	3.4							
1.1.2.1 Effect of fertilization on whole ecosystem carbon sequestration, including soil carbon												113	115							2	1.4									0	0.0						
1.1.2.1 high productivity coastal forest sites - already well-studied, but need more information on soil C																		0	0.0									0	0.0								
1.1.2.2southern interior and northern interior forest types - not well studied																		0	0.0	3	7							2	2.2								
1.1.2.2 Effect of alternative tree species, such as nitrogen-fixing red alder, & mixtures on C sequestration (esp. long-term soil carbon), compared to traditional high yield conifer plantations												106	114							2	1.4	100							1	1.1							
1.1.2.3 Effect of alternative silvicultural practices such as variable retention on carbon sequestration (especially long term soil carbon), compared to traditional high yield plantations																		0	0.0									0	0.0								
1.1.2.4 Effect of managing for old growth at long rotations vs high intensity management of short rotations, across stand to regional scales																		0	0.0									0	0.0								
1.1.2.5 Ecological studies related to the application of biocharcoal to soil to enhance C sequestration																		0	0.0									0	0.0								
1.2 Industrial research -that directly contributes to carbon cycle models																		0	0.0									1	1.1								
1.2.1 Carbon cycling and storage in the wood products lifecycle, particularly as it relates to the use of salvaged or othe novel wood products.																		0	0.0	114									1	1.1							
1.2.1.1 effects of converting rapidly degrading forest biomass to recalcitrant C (biocharcoal) (from Black et al. 2008)																		0	0.0									0	0.0								
1.2.1.1 engineering studies related to the development of biocharcoal and its potential uses																		0	0.0									0	0.0								
1.2.1.3 economic studies of the use of biocharcoal																		0	0.0									0	0.0								
1.2.2 Research addressing carbon cycling and reduction of GHG emissions in forestry operations (eg harvesting, roads, silviculture equipment use).																		0	0.0									0	0.0								
1.3 Mitigation-Adaptation integration																		0	0.0									2	2.2								
1.3.1 Effect of adaptation measures to promote ecosystem resilience on carbon sequestration																		0	0.0									0	0.0								
1.3.2 Effect of mitigation measure to promote carbon sequestration on ecosystem resilience																		0	0.0									0	0.0								
1.3.3 Effect of adaptation measures to promote resilient, sustainable communities resilience on carbon sequestration																		0	0.0	65							1	1.1									
1.3.4 Effect of mitigation measure to promote carbon sequestration on community resilience & sustainability																		0	0.0	82							1	1.1									
1.3.5 Community sustainability and regional planning initiatives & education related to enhancing resilience through carbon forestry.																		0	0.0									0	0.0								
1.3.6 Ensuring that national & provincial carbon mitigation policies have positive not negative effects on local communities & ecosystems																		0	0.0									0	0.0								
1.3.7 Local or field level policy changes needed to facilitate carbon sequestration (eg silvicultural regulations)																		0	0.0									0	0.0								
2 Impacts = Monitoring, Predicting, & Modeling Change, Vulnerability and Risk Assessments in Forest and Range Ecosystems																				71	50.7									34	38.2						
2.1 Predicting Climate Change Impacts on Forest and Range Species and Ecosystems																				63	45.0									29	32.6						
2.1.1 Genetics (see Aitken et al. 2008)												117								3	2.1									0	0.0						
2.1.1.1 Genomics of keystone species including epigenetic effects												162								1	0.7									0	0.0						
2.1.1.2 Further studies using existing provenance trials for fecundity, controlled crosses etc																			0	0.0									0	0.0							
2.1.1.3 Short-term (laboratory) common garden experiments to determine genetic variability in response to stressors, elevated C02												38	39							2	1.4									0	0.0						
2.1.1.4 Genetic studies in zones of natural hybridization																			0	0.0									0	0.0							
2.1.2 Physiology & population ecology																			14	10.0									5	5.6							
2.1.2.1 Development of complex species dispersal models (SDMs) that go beyond climate envelope modelling to include other ecological factors												21								1	0.7									0	0.0						
2.1.2.2 Field & lab experiments to study physiological response of keystone species to to climate variables and interacting factors												47								1	0.7	1	150							2	2.2						
2.1.2.3 Field experiments that provide parameter estimates and field verification of SDMs																			0	0.0									0	0.0							
2.1.2.4 Field monitoring and vulnerability assessments of keystone species (trees, shrubs, grasses, forbs, vertebrates, invertebrates)																			9	6.4									1	1.1							
2.1.2.4.1 major tree species												1	18	19	37	160	5	3.6									0	0.0									
2.1.2.4.2 other vegetation												44								1	0.7									0	0.0						
2.1.2.4.3 major species of wildlife & fish												44	108	109							3	2.1	74							1	1.1						
2.1.2.4.4 other animal species																			0	0.0									0	0.0							
2.1.2.4.5 mycorrhizal fungi, other microbial life																			0	0.0									0	0.0							
2.1.2.5 Effects of climate change on insect and disease population dynamics & host-pest interactions												23	24							2	1.4	22	36							2	2.2						
2.1.2.6 Effects of climate change on invasive alien species												50								1	0.7									0	0.0						
2.1.3 Community, Ecosystem & Landscape ecology																			27	19.3									12	13.5							
2.1.3.1 Effects of climate change on ecosystem function and dynamics, water and nutrient storage and cycling												55								1	0.7	31							1	1.1							
2.1.3.2 Effects of climate change on disturbance regimes at various scales																			13	9.3	142							5	5.6								
2.1.3.2.1 wildfire												54	90	148							3	2.1	20	149							2	2.2					
2.1.3.2.2 insects & disease (see Abbott et al. 2007)												23	24	41	45	49	51	56	88	123	126	10	7.1	36	37							2	2.2				
2.1.3.2.3 storms, flooding,																			0	0.0									0	0.0							
2.1.3.3 Community to landscape level changes in forest and range ecosystems												42	44							2	1.4	69							1	1.1							
2.1.3.4 Adapting ecosystem classification (BEC) approaches to a changing climate												73								1	0.7	32							1	1.1							
2.1.3.5 Ecosystem-level consequences of assisted migration (soil organisms, invasive species, cascading effects on foodwebs)												47								1	0.7									0	0.0						
2.1.3.6 Ecosystem-level consequences of altered competitive abilities among species (eg below-ground effects)												143								1	0.7									0	0.0						
2.1.3.7 Ecotonal shifts -forest to grassland, timberline advance												44	148							2	1.4	55	101	31							3	3.4					
2.1.3.8 Use of backcasting and historic range of variability tools (dendrochronology, paleoecology, archaeology, oral history) to predict the future												11	123	134	135	139	148							6	4.3									0	0.0		
2.1.3.9 Effects of climate change on wildlife habitat supply																			0	0.0	74							1	1.1								
2.1.4 Earth sciences (Hydrology & Geomorphology)																			5	3.6									3	3.4							
2.1.4.1 Changes in water storage, peak flow timing etc												4	71	94	161							4	2.9	79	164	170							3	3.4			
2.1.4.2 Effects on mass movements, landslides, glacial melt effects on slope stability												147								1	0.7									0	0.0						
2.1.5 Aquatic Ecosystems												111	153							4	2.9									0	0.0						
2.1.5.1 Interactions of forest practices and climate change on stream temperatures and associated												28	52							2	1.4									0	0.0						
2.1.6 Forest and Range Growth & Yield Modeling for a changing climate																			5	3.6									7	7.9							
2.1.6.1 Consequences of climate change on tree growth & timber supplies												37	40	57	104	107							5	3.6	1	18	70	83	85							5	5.6
2.1.6.2 Consequences of changing species mixes on timber supplies																			0	0.0	143							1	1.1								
2.1.6.3 Consequences of increased stand complexity & increased stress resistance on growth & yield																			0	0.0									0	0.0							
2.1.6.4 Consequences of climate change on rangeland productivity and carrying capacity for wild ungulates and cattle																			0	0.0	74							1	1.1								
2.1.7 Integrated modelling approaches that combine information from various levels of biological organization and disciplines																			4	2.9									2	2.2							
2.1.7.1 Metamodeling approaches and new methodologies for synthesizing & integrating results												31								1	0.7									0	0.0						
2.1.7.2 Complex ecological interactions																			3	2.1	47							2	2.2								
2.1.7.2.1 effect of interactions between genes & pathogens on keystone species vulnerability																			0	0.0									0	0.0							
2.1.7.2.2 effect of interactions among climate, fire regime, insects & disease on keystone species & ecosystems (see Abbott et al. 2007)												11	22	36							3	2.1	31							1	1.1						
2.1.7.2.3 effect of interactions among climate, invasive species, disturbance regimes, on keystone species & ecosystems																			0	0.0									0	0.0							
2.2 Monitoring and Risk Assessment																			8	5.7									5	5.6							
2.2.1 Improved methods for risk assessment (rapid, multi-scale, complex interactions)																			0	0.0	49							1	1.1								
2.2.2 Monitoring reproduction & regeneration of species at risk to determine need for facilitated migration												147								1	0.7									0	0.0						
2.2.3 Integrating climate model projections into existing or modified models												105	30	31							3	2.1	72	165							2	2.2					

2.2.4	Mapping and display tools for communicating climate change impacts	163	1	0.7		0	0.0
2.2.5	Development of more cost-effective monitoring technologies (remote sensing)		0	0.0		0	0.0
2.2.6	Harmonizing monitoring networks & methods & integrating climate change monitoring with other monitoring	68 83	2	1.4		0	0.0
2.2.7	Development and testing for new ecological indicators to assess climate change vulnerability, resilience etc	32	1	0.7	75 157	2	2.2
3 Adaptation of Forest and Range Policies and Practises to reduce environmental, social and economic consequences of climate change			15	10.7		15	16.9
3.1	Gene management		5	3.6		2	2.2
3.1.1	Assisted or facilitated migration	33 117	3	2.1		0	0.0
	3.1.1.1 seed transfer guidelines	80	1	0.7		0	0.0
	3.1.1.2 population response curves		0	0.0		0	0.0
	3.1.1.3 expanded provenance trials to test effects of extreme climate		0	0.0		0	0.0
3.1.2	Selection and breeding of stock for pest resistance and tolerance of climatic extremes	106	1	0.7		0	0.0
3.1.3	Evaluation of seed orchards to ensure a sustainable seed supply	159	1	0.7	155	1	1.1
3.1.4	Conservation and recovery program evaluation for species at risk		0	0.0	47	1	1.1
3.2	Forest Protection (fire, insects, diseases, other invasive species) & Protection Forests		0	0.0	20	1	1.1
3.2.1	Developing fire-smart and climate-smart landscapes through combinations of harvesting, regeneration & stand tending (multi-scale)		0	0.0		0	0.0
3.2.2	Development of triage strategies for forest protection - identifying areas with high economic & social value for focussed protection efforts		0	0.0		0	0.0
3.2.3	Enhancing stand and forest resistance to stresses through changing silvicultural practices (see Silviculture)		0	0.0	24	1	1.1
3.2.4	Enhancing forest recovery after disturbance (see Silviculture)		0	0.0		0	0.0
3.2.5	Development of contingency, emergency response and recovery plans to deal with extreme events		0	0.0		0	0.0
3.2.6	Enhanced pest control strategies and practices		0	0.0		0	0.0
3.3	Regeneration and Silviculture (includes methods & model development, new trials, monitoring & evaluation of existing trials)		6	4.3		6	6.7
3.3.1	Changes in species selection, planting & stand tending guidelines & policies -assessment of existing policy by CC experts	78 81 84	3	2.1	19 86	2	2.2
3.3.2	Operational implementation of mixed provenances and species, stress-resistant genotypes, underplanting trials		0	0.0		0	0.0
3.3.3	Vegetation management, invasive species control, and stand tending trials to improve regeneration success & enhance stand vigour		0	0.0		0	0.0
3.3.4	Fast-growing plantations and short rotations for biomass energy and to reduce risk		0	0.0		0	0.0
3.3.5	Restoration of damaged ecosystem productivity and function		0	0.0		0	0.0
3.3.6	Assisted migration of commercial tree species	33 63	2	1.4		0	0.0
3.3.7	Policy changes needed to facilitate carbon storage		0	0.0	82	1	1.1
3.3.8	Afforestation and reforestation opportunities in current non-forest lands	146	1	0.7	85	1	1.1
3.3.9	Silvicultural systems to enhance structural complexity, productivity and resilience		0	0.0		0	0.0
3.3.10	Natural vs artificial regeneration		0	0.0		0	0.0
3.3.11	Modifications to nursery practices to accommodate changing climate & enhance stress resistance		0	0.0	150	1	1.1
3.3.12	Reducing other stressors (pollution, forest health, invasives) to improve forest health and resilience to climate change		0	0.0	150	1	1.1
3.4	Forest, Range and Recreation operations (harvesting, road access,	46	2	1.4		1	1.1
3.4.1	Improving and increasing salvage & biomass energy harvests while reducing ecological impact		0	0.0		0	0.0
3.4.2	Road system management to reduce vulnerabilities	25	1	0.7		0	0.0
3.4.3	Mitigating impacts on infrastructure and habitat (fish, water quality & quantity)		0	0.0	121	1	1.1
3.4.4	Adapting certification systems to address vulnerabilities (see Socio-economics below)		0	0.0		0	0.0
3.4.5	Grazing system management to reduce vulnerabilities and ecological impact		0	0.0		0	0.0
3.4.6	Policy development that enhances flexibility and adaptive management in forest, range and recreation management		0	0.0		0	0.0
3.5	Wildlife and Biodiversity management in forests and rangelands		2	1.4	74	2	2.2
3.5.1	Reducing fragmentation and maintaining connectivity to facilitate migration		0	0.0		0	0.0
3.5.2	Adapting forest type and age class distributions to ensure habitat continuity		0	0.0		0	0.0
3.5.3	Ensuring maintenance of functional group diversity in a rapidly changing environment		0	0.0		0	0.0
3.5.4	Active management of wilderness (& Parks?) to maintain or restore biodiversity and ecosystem function		0	0.0		0	0.0
3.5.5	Assisted migration of non-commercial species & keystone elements for biodiversity management		0	0.0		0	0.0
3.5.6	Buffering sensitive habitats (eg riparian zones) against changing climatic & hydrological regimes	53 64	2	1.4	28	1	1.1
3.6	Forest, Range and Land Use Planning		0	0.0	46	2	2.2
3.6.1	Rapid review of existing plans by climate change experts to identify conflicts & gaps		0	0.0		0	0.0
3.6.2	Incorporating climate change into existing plans and future planning		0	0.0	87	1	1.1
3.6.3	Incorporating new risk assessment methods into management plans		0	0.0		0	0.0
3.6.4	Agroforestry opportunities in a changing climate		0	0.0		0	0.0
4 Social and Economic Impacts, Vulnerability and Adaptation			34	24.3		26	29.2
4.1	Social and Economic Impact Analyses of climate change with and without mitigation and adaptation strategies		23	16.4	82 120 131 153 156 157	10	11.2
4.1.1	Economic analysis of effects on timber supply, non-timber forest products, rangeland resources and other ecosystem services	45 140	2	1.4	65 69 151 152	4	4.5
4.1.2	Enhancing socio-ecological resilience & adaptive capacity	13 91 95 95 97 122 125 132	8	5.7	8 14 92	3	3.4
4.1.3	Effects of adaptation on market values of forest & range products; identifying critical thresholds for change in economic structure	136 146	2	1.4	15	1	1.1
4.1.4	New opportunities for the forest and range sector in a warmer climate	151 152	2	1.4	82 103	2	2.2
4.1.5	Northern economies & communities in a warmer climate	138 144	2	1.4		0	0.0
4.1.6	Using archaeological and anthropological methods to understand societal adaptation to climate change	127 128 134 135 137 139 170	7	5.0		0	0.0
4.2	Forest Sector and Community Communication, Education and Public Participation		4	2.9		8	9.0
4.2.1	Improving adaptive capacity of forest sector personnel		0	0.0	20 75 77 93 142	5	5.6
4.2.2	Improved ability to communicate climate change impacts, risks & uncertainties to forest sector and public - eg through scenario analysis	16 70	2	1.4		0	0.0
4.2.3	Adapt uncertainty techniques from management science, econometrics, insurance & engineering		0	0.0	70	1	1.1
4.2.4	Methods to enhance cross-sectoral communication & thinking		0	0.0		0	0.0
4.2.5	Strengthening community capacity to adapt to change	2 145	2	1.4	13 158	2	2.2
4.3	Behavioural Research (adapting best available science to forest & range sectors)		2	1.4		0	0.0
4.3.1	Enhancing management flexibility		0	0.0		0	0.0
4.3.2	Understanding decision-making, inertia, factors that create change	124 129	2	1.4		0	0.0
4.4	Policy and Legal Analysis	67 141	5	3.6		2	2.2
4.4.1	Assessing institutional barriers to change and improved approaches for enhancing flexibility		0	0.0	70	1	1.1
4.4.2	Rapid review of existing policy & legislation by climate change experts to identify conflicts & gaps		0	0.0		0	0.0
4.4.3	Governance, policies & legal frameworks that enhance adaptive capacity	89 130 133	3	2.1	2	1	1.1
4.4.4	Policy instruments needed to ensure that benefits flow to local areas experiencing impacts		0	0.0		0	0.0
4.4.5	Strengthening policies related to invasive species		0	0.0		0	0.0
4.5	Economic analysis of opportunities		0	0.0		0	0.0
4.5.1	New forest economies & products		0	0.0		0	0.0
4.5.2	Improved methods of including climate change externalities (eg cost of fire protection) into costing for new products (bioenergy)		0	0.0		0	0.0
			140	100.0		89	100.0