

**UNITED STATES AIR FORCE
66TH AIR BASE GROUP
HANSCOM AIR FORCE BASE**

**INTEGRATED NATURAL RESOURCES
MANAGEMENT PLAN**



(See INRMP signature pages for plan approval date)

1 **ABOUT THIS PLAN**

2 This installation-specific Environmental Management Plan (EMP) is based on the United States Air Force’s
3 (USAF) standardized Integrated Natural Resources Management Plan (INRMP) template. This INRMP has
4 been developed in cooperation with applicable stakeholders, which includes Sikes Act cooperating agencies
5 and/or local equivalents, to document how natural resources will be managed. Where applicable, external
6 resources, including Air Force Instructions (AFIs); Department of Defense Instructions (DoDIs); USAF
7 Playbooks; federal, state, and local requirements; Biological Opinions; and permits are referenced.

8 Certain sections of this INRMP begin with standardized, USAF-wide “common text” language that address
9 USAF and Department of Defense (DoD) policy and federal requirements. This common text language is
10 restricted from editing to ensure that it remains standard throughout all plans. Immediately following the
11 USAF-wide common text sections are installation sections. The installation sections contain installation-
12 specific content to address local and/or installation-specific requirements. Installation sections are
13 unrestricted and are maintained and updated by the approved plan owner.

14 *NOTE: The terms “Natural Resources Manager” (NRM) and “NRM/POC” are used throughout this*
15 *document to refer to the installation person responsible for the natural resources program, regardless of*
16 *whether this person meets the qualifications within the definition of a natural resources management*
17 *professional in DoDI 4715.03, Natural Resources Conservation Program.*

18



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165 **DOCUMENT CONTROL**

166 ***Standardized INRMP Template***

167 In accordance with (IAW) the Air Force Civil Engineer Center Environmental Directorate's Business Rule
168 08, *EMP Review, Update, and Maintenance*, the standard content in this INRMP template is reviewed
169 periodically, updated as appropriate, and approved by the Natural Resources Subject Matter Expert.

170 This version of the template is current as of 06/26/2020 and supersedes the 2018 version.

171 *NOTE:* Installations are not required to update their INRMPs every time this template is updated. When it
172 is time for installations to update their INRMPs, they should refer to the eDASH EMP Repository to ensure
173 they have the most current version.

174 ***Installation INRMP***

175 **Record of Review**—The INRMP is updated no less than annually, or as changes to natural resource
176 management and conservation practices occur, including those driven by changes in applicable regulations.
177 IAW the Sikes Act and Air Force Manual (AFMAN) 32-7003, *Environmental Conservation*, the INRMP
178 is required to be reviewed for operation and effect no less than every five years. An INRMP is considered
179 compliant with the Sikes Act if it has been approved in writing by the appropriate representative from each
180 cooperating agency within the past five years. Approval of a new or revised INRMP is documented by
181 signature on a signature page signed by the Installation Commander (or designee), and a designated
182 representative of the United States Fish and Wildlife Service (USFWS), state fish and wildlife agency, and
183 National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries)
184 when applicable (AFMAN 32-7003).

185 Annual reviews and updates are accomplished by the installation NRM, and/or a Section Natural Resources
186 Media Manager. The installation shall establish and maintain regular communications with the appropriate
187 federal and state agencies. At a minimum, the installation NRM (with assistance as appropriate from the
188 Section Natural Resources Media Manager) conducts an annual review of the INRMP in coordination with
189 internal stakeholders and local representatives of USFWS, state fish and wildlife agency, and NOAA
190 Fisheries, where applicable, and accomplishes pertinent updates. Installations will document the findings
191 of the annual review in an Annual INRMP Review Summary. By signing the Annual INRMP Review
192 Summary, the collaborating agency representative asserts concurrence with the findings. Any agreed
193 updates are then made to the document, at a minimum updating the work plans.

194 The first fully implemented INRMP for Hanscom Air Force Base was developed in 2023 and covers a five-
195 year planning period, 2023 plus four additional years.

196

197 **INRMP APPROVAL/SIGNATURE PAGES**

198 **Integrated Natural Resources Management Plan**

199 **Hanscom Air Force Base, Massachusetts**

200 This INRMP has been prepared in accordance with regulations, standards and procedures of the Department
201 of Defense and the United States Air Force in cooperation with the USFWS, NMFS, and Massachusetts
202 Division of Fisheries and Wildlife.

203

204

205

206 _____
206 Col. Taona A. Enriquez
207 Commander
208 66th Air Base Group
209

_____ Date

210

211

212 _____
212 Audrey Mayer, Ph.D.
213 Supervisor
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215 United States Fish and Wildlife Service, Region 5
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220 Eve Schlüter, Ph.D.
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222 Natural Heritage & Endangered Species Program
223 Massachusetts Division of Fisheries and Wildlife
224

_____ Date

224

225

226

227 _____
227 Michael Pentony
228 Regional Administrator
229 Greater Atlantic Regional Fisheries
230 National Marine Fisheries Service
231

_____ Date

232 **EXECUTIVE SUMMARY**

233 This INRMP was developed in accordance with the Sikes Act of 1960 (16 United States Code [U.S.C.]
234 §670 *et seq.* as amended), which requires that all DoD installations to carry out a program for conserving
235 and restoring natural resources. It also requires that all installations that meet certain natural resources
236 criteria (summarized under the umbrella of “significant natural resources;” i.e., Category 1 installations)
237 develop an INRMP to provide a framework for and guide the natural resources program. If it is determined
238 that the installation does not meet the Category I criteria, then an INRMP is not required (Category II
239 installation). Originally, Hanscom Air Force Base (Hanscom AFB, or HAFB), of the USAF, qualified as a
240 Category II installation and did not require an INRMP; instead, there was a memorandum of agreement
241 between HAFB and the Massachusetts Division of Fisheries and Wildlife (hereafter, MassWildlife) for
242 addressing any emergent natural resource concerns. Since then, an enhanced need to manage for state and
243 federal threatened and endangered (T&E) species on the installation and upcoming installation development
244 led to the determination that now HAFB must have—and implement—an INRMP.

245 The primary overarching documents that pertain to natural resources programs on USAF installations and
246 INRMP development, updating, and revising include AFMAN 32-7003; Air Force Policy Directive (AFPD)
247 32-70, *Environmental Considerations in Air Force Programs and Activities* (30 Jul 2018); and DoDI
248 4715.03, *Natural Resources Conservation Program* (18 Mar 2011, Incorporation Change 2, 31 Aug 2018).
249 Requirements and guidance also are provided in several laws, Executive Orders (EOs), and other DoD and
250 USAF directives, instructions, and policies, which are discussed in context, as needed, and included in
251 [Appendix A](#) of this INRMP. The INRMP supports the USAF mission by integrating the installation’s
252 military mission with its natural resources management program to ensure (1) no net loss in military
253 capabilities and needs; (2) conservation and restoration of natural resources and ecosystem services,
254 including those necessary to the military mission; and (3) compliance with federal and local laws that
255 pertain to natural and cultural resources. In addition, the INRMP must be integrated with the installation’s
256 other plans that affect natural resources on base, including, but not limited to, the Installation Development
257 Plan (IDP), Ground and Landscaping Plan, Pest Management Plan, and Integrated Cultural Resources
258 Management Plan (ICRMP). The INRMP is a living document that requires annual review and updating.
259 Major reviews for operation and effect are required every five years to revise the plan as needed, seek
260 concurrence from federal and state regulatory agencies, and develop implementation plans for the
261 subsequent five years.

262 Hanscom AFB comprises over 900 acres, including the main base and numerous geographically separated
263 units (GSUs). The main base consists of 846 acres located 18 miles northwest of Boston in Middlesex
264 County, Massachusetts, and overlaps the historic Towns of Bedford, Lincoln, and Lexington. Two of the
265 GSUs are included in this INRMP: Fourth Cliff Recreational Annex (hereafter, 4th Cliff), a 56-acre site
266 located on the coast 40 miles southeast of the main base in Scituate, MA, and Sagamore Hill Solar Weather
267 Observatory (hereafter Sagamore Hill), a 32-acre site located 25 miles northeast of the main base in
268 Hamilton, MA. Other GSUs do not warrant inclusion within this INRMP. In addition, the base operates the
269 Patriot Golf course, a recreation area for installation personnel, dependents, and their guests, and Veterans
270 Administration patients, personnel, and guests. The Patriot Golf Course lies on property owned by the
271 Veterans Administration and the USAF has a permit to operate and use the golf course.

272 In 1941, the Boston Auxiliary Airport was established on the site that is now HAFB. When the United
273 States entered World War II, the site became a military installation, the primary mission of which was to
274 train fighter squadrons deployed to Europe and Africa. Since then, the HAFB mission has undergone
275 numerous evolutions, and today its primary mission is to provide support to the Air Force Life Cycle
276 Management Center (AFLCMC) and the Massachusetts Institute of Technology (MIT) Lincoln Laboratory

277 for research and life cycle management of USAF Command, Control, Communications, Computer, and
278 Intelligence systems. The 4th Cliff site provides recreational opportunities for DoD personnel, families, and
279 guests; and Sagamore Hill houses solar weather-tracking and radar equipment.

280 An INRMP must follow the ecosystem management principles and guidelines outlined in AFMAN 32-7003
281 and in DoDI 4715.03. Important to these principles is developing an ecosystem-level perspective to
282 planning and management, and also ensuring that the INRMP objectives may be met in the face of changing
283 conditions and/or unexpected outcomes. INRMP development entails (1) describing the base's profile,
284 including its history, current and expected land use, and future constraints that natural resources place on
285 the military mission and vice versa; the abiotic environment; and the biotic resources; (2) describing the
286 management issues and needs for each category of natural resources; and (3) outlining the goals, objectives,
287 and projects for addressing those needs, followed by a five-year plan for implementing projects, including
288 funding, timelines, and priority level. The goals express broad guiding principles for the program, including
289 the desired condition in the installation's natural resources, and are the primary focal points for INRMP
290 implementation. The objectives for each goal indicate ~~measureable~~ measurable targets for achieving the goal
291 and are supported by projects, which are specific actions that can be accomplished within a single year or
292 in yearly phases. What emerged through development of the HAFB INRMP were five goals, each with two
293 to six objectives and a variety of projects to achieve the objectives. Overall categories of objectives at
294 HAFB and its GSUs over the initial five-year span of this INRMP are summarized as follows:

- 295 1. Conduct thorough inventory and establish monitoring surveys to determine current presence, status,
296 and trends of the base's vegetation, wildlife, and wetland resources, with a special focus on species
297 listed as threatened or endangered (federal and state listed) and state-listed species of special
298 concern.
- 299 2. Provide necessary training to natural resources staff for INRMP implementation and managing the
300 base's natural resources.
- 301 3. Assess and determine mitigation actions needed for addressing current and projected impacts of
302 climate change, particularly as they relate to flooding and coastal erosion.
- 303 4. Develop an overall adaptive management approach that incorporates short- and long-term needs
304 and prioritizes functional diversity, habitat variability and connectivity, and habitat/species
305 resilience to climate change.
- 306 5. Develop specific management plans for key vegetation communities and habitats, such as forests,
307 and wetlands, to preserve and enhance plant and wildlife habitats and the ecosystem services they
308 provide at HAFB and its GSUs.
- 309 6. Coordinate with grounds and golf course maintenance staff to minimize practices that are
310 detrimental and maximize practices that are beneficial to native flora and fauna, including
311 pollinators.
- 312 7. Develop a robust program for detecting and controlling or eradicating nonnative and/or invasive
313 plant species and animal pests, including invertebrate species.
- 314 8. Provide recreation and public outreach/education opportunities, such as a citizen science program
315 to monitor pollinators and educational pamphlets about key sensitive species and resources on base,
316 to support and enhance the natural resources program.

317 Achieving these objectives will provide an array of benefits to HAFB. It will help to ensure that the base
318 can carry out its mission into the future; comply with federal and state or local laws and regulations; prepare
319 for and mitigate deleterious effects of climate change; preserve habitats, species, and ecosystem services
320 for future generations; and support the health and safety, recreational opportunities, and morale of DoD
321 staff, their families and guests, and surrounding communities. Another major outcome of this INRMP will
322 be to help fill crucial data gaps in the overall inventory of natural resources in Massachusetts. This INRMP

323 is likely to require some shifting of the base’s natural resource priorities and a significant expansion of its
324 natural resources program to achieve the goals and objectives. Cooperating with other agencies and seeking
325 assistance from universities, non-governmental organizations, and private businesses to help accomplish
326 projects may be necessary. With this programmatic escalation, however, HAFB should be in a much better
327 position to continue to accomplish its military mission.

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328 **1.0 OVERVIEW AND SCOPE**

329 This Integrated Natural Resource Management Plan (INRMP) was developed to provide for effective
 330 management and protection of natural resources at Hanscom Air Force Base (HAFB or Hanscom AFB). It
 331 summarizes the state of natural resources present on the installation and outlines strategies for adequately
 332 managing them. Natural resources are valuable assets of the United States Air Force (USAF) because they
 333 provide the natural infrastructure needed for testing weapons and technology and training military personnel
 334 for deployment. Sound management of natural resources increases the effectiveness of USAF adaptability
 335 in all environments. The USAF has stewardship responsibility for the physical lands on which installations
 336 are located to ensure that all natural resources are properly conserved, protected, and used in sustainable
 337 ways. The primary objective of the USAF natural resources program is to sustain, restore, and modernize
 338 natural infrastructure to ensure operational capability and no net loss in the capability of USAF lands to
 339 support the military mission. This INRMP outlines and assigns responsibilities for natural resources
 340 management, discusses related concerns, and provides program management elements that will help to
 341 maintain or improve the natural resources within the context of the base's mission. This INRMP is intended
 342 for use by all installation personnel. The Sikes Act is the legal driver for the INRMP.

343 ***1.1 Purpose and Scope***

344 The purpose of this INRMP is to guide the management of natural resources on HAFB lands. It (1) provides
 345 the background information necessary for guiding and planning the base's natural resources management
 346 program; (2) develops specific goals and objectives for managing the base's natural resources; and (3)
 347 provides the rationale for funding the implementation of specific projects for meeting the goals and
 348 objectives to conserve and restore the base's natural resources. In accordance with (IAW) the Sikes Act and
 349 Air Force Manual (AFMAN) 32-7003, this INRMP integrates the base's need to continue achieving its
 350 military mission for conducting realistic military testing; managing the life cycle of USAF weaponry
 351 systems; and providing education/training, health services, and recreational opportunities for 140,000
 352 Department of Defense (DoD), civilian, contractor, and retired personnel and their dependents, while also
 353 conserving, restoring, and sustaining the base's ecological integrity. The overarching INRMP intent is to
 354 integrate the base's (a) need for realistic environmental conditions under which military personnel training
 355 and equipment testing may be conducted and its need to improve and expand the facilities for achieving its
 356 military mission with (b) its need to comply with federal mandates to conduct responsible stewardship of
 357 the installation's natural resources and their vital ecosystem services.

358 More specifically, this INRMP

- 359 • summarizes the HAFB-specific information necessary for planning and implementing
360 management actions and projects;
- 361 • summarizes the internal and external data, documents, and literature pertaining to the natural
362 resources at HAFB including recent climate change projections;
- 363 • analyzes and integrates the goals and objectives of all HAFB management plans for other base
364 resources (e.g., installation development, landscaping and grounds, pest management);
- 365 • supports and provides the steps needed to fulfill compliance requirements with applicable
366 regulations and policies;
- 367 • ensures that installation activities are consistent with federal mandates for fostering land
368 stewardship;
- 369 • supports the integration of natural resources stewardship with USAF mission activities; and

- 370 • provides resource-specific guidance and strategies for managing, monitoring, and restoring
- 371 natural resources.

372 This INRMP is organized into the principal sections listed below.

- 373 • An overview of the current status and foreseeable future conditions of the installation’s natural
- 374 resources;
- 375 • Identification and discussion of constraints on military mission activities arising from natural
- 376 resources and, conversely, potential impacts to natural resources from military mission activities;
- 377 • An outline of the base’s goals and objectives for its natural resources; and
- 378 • Specific work plans for effectively implementing this INRMP and meeting the goals and
- 379 objectives for natural resources management through specific management recommendations or
- 380 projects.

381 The scope of this INRMP includes the 846-acre main base, which overlaps the townships of Bedford,
 382 Lincoln, and Lexington in Middlesex County, Massachusetts, including land occupied by the base’s tenant
 383 organizations and the adjacent recreational FamCamp. It also includes two of the base’s geographically
 384 separated units (GSUs): Fourth Cliff Recreation Annex (hereafter, 4th Cliff) on Humarock Peninsula in
 385 Scituate; and Sagamore Hill Solar Weather Observatory Annex (hereafter, Sagamore Hill) in Hamilton, and
 386 property permitted by the Veteran’s Administration, the Patriot Golf Course. It addresses the natural
 387 resources encompassed by the base and its GSUs, including, but not limited to, wetlands and forest
 388 fragments, coastal environments, and fish and wildlife, with an emphasis on ~~federally listed~~ federally listed
 389 species and other species of concern.

390 The region in which HAFB is located was originally inhabited by numerous Native American tribes,
 391 particularly in the Shawsheen River basin that partially overlaps HAFB. HAFB also has some historical
 392 cultural resources, primarily buildings that are or may be eligible for the National Register of Historic
 393 Places, from the World War II era. These cultural resources also must be considered during planning and
 394 protected during execution of military and natural resources management activities; thus, to the extent that
 395 they could be affected by natural resources management, they are also discussed in this INRMP. Additional
 396 resources and sources of potential environmental concern addressed herein include water resources and
 397 floodplains, the grounds and landscaping, ~~pest~~ pests and nonnative species, climate change, and outdoor
 398 recreation. Also incorporated into this INRMP are management goals and objectives for geographic
 399 information systems (GIS) and public outreach/education.

400 ***1.2 Management Philosophy***

401 This INRMP supports HAFB’s military mission by (1) identifying and describing the natural resources
 402 present on and needed by the installation for achieving its military missions; (2) developing management
 403 goals and objectives for protecting, restoring, and/or sustaining those resources; and (3) integrating
 404 management objectives into the military requirements for mission operations/support and regulatory
 405 compliance to minimize natural resource constraints on the base’s ability to achieve its military mission.
 406 The long-term goal of this INRMP is to integrate all management activities in a manner that sustains,
 407 promotes, and/or restores the health and integrity of the base’s natural resources.

408 Management issues and concerns, and their associated goals and objectives, were developed for this
 409 INRMP through analysis of all the relevant information gathered by the HAFB personnel and other internal
 410 stakeholders involved with or responsible for various aspects of natural resources management at HAFB.
 411 Using an interdisciplinary approach, this INRMP was developed on the basis of existing information about
 412 all components of the biotic and abiotic environments, mission activities, and environmental management

413 practices at HAFB. Supporting information was obtained from a variety of HAFB documents, a thorough
414 literature search, communications with installation personnel, and on-site observations. This INRMP also
415 incorporates communications with external stakeholders, including, but not limited to, the United States
416 Fish and Wildlife Service (USFWS), Massachusetts Division of Fisheries and Wildlife (MassWildlife), and
417 National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).
418 This cooperative approach to INRMP development included documenting coordination and correspondence
419 with these agencies and satisfies a portion of the 32 Code of Federal Regulations (CFR) 989, *Environmental*
420 *Impact Analysis Process* (EIAP) requirements.

421 In accordance with AFMAN 32-7003 and Department of Defense Instruction (DoDI) 4715.03, *Natural*
422 *Resources Conservation Program*, this INRMP adheres to the USAF principles of ecosystem-level
423 management for achieving and sustaining land and natural resource conditions. These principles include
424 maintaining or restoring (1) native ecosystem types across their natural ranges; (2) natural ecological
425 processes, such as fire and other natural disturbance regimes; and (3) hydrological processes in streams,
426 floodplains, and wetlands when feasible, practical, and consistent with the base's military missions. They
427 also include (4) using a regional approach for implementing ecosystem management by collaborating with
428 other DoD components, and with other Federal, state, and local agencies and adjoining property owners;
429 and (5) providing for outdoor recreation (both consumptive and non-consumptive) and practical uses of the
430 land and its resources, provided that it does not inflict long-term ecosystem damage or negatively impact
431 the USAF mission.

432 Adaptive management approaches recognize the underlying complexities of functional ecosystems and
433 comply with the intent of AFMAN 32-7003 to ensure environmentally sound stewardship of the nation's
434 natural resources on USAF lands. In keeping with the principles of adaptive management, this INRMP also
435 incorporates the necessary ongoing monitoring and analyses of trends in resource conditions to ensure that
436 goals and objectives are met. Management practices may need adjustment if/when monitoring data or other
437 information indicate that current management strategies are ineffective, mission requirements change and
438 result in adverse effects to or from natural resources, and/or there are changes to regulations governing the
439 management of natural resources.

440 **1.3 Authority**

441 **Hanscom Air Force Base's Category II History**

442 The Sikes Act, 16 United States Code (U.S.C.) §670 *et seq.*, requires the DoD to ~~carry out~~ conduct a program
443 for the conservation and restoration of natural resources on military installations. More specifically, it
444 requires each military department to prepare and implement a comprehensive INRMP for each of its
445 Category I installations. According to AFMAN 32-7003, Category I installations are those with significant
446 natural resources. Significant natural resources are present if any of the following apply:

- 447 • training and/or testing operations are conducted on-the-ground on unimproved lands that
448 necessitate practices and management to maintain the natural resources and minimize the impacts
449 of military testing and training activities;
- 450 • there are threatened and/or endangered (T&E) species listed under the federal Endangered
451 Species Act (ESA) (16 U.S.C. § 1531 *et seq.*), or designated/proposed critical habitat present on
452 the installation and active conservation measures are necessary to conserve the species;
- 453 • outdoor recreation activities, including hunting, fishing, or off-road vehicle use are permitted on
454 the installation when consistent with the military mission;

- 455 • the installation operates commercial outgrants for grazing animals, agricultural crop production,
456 or horseback riding on unimproved lands;
- 457 • the installation operates a commercial forestry program, or implements a forest management
458 program to support military training, maintain forest health, or to support ecosystem management
459 goals and objectives;
- 460 • the installation has significant bird/wildlife aircraft strike hazard (BASH) issues that necessitate
461 active management including habitat manipulation on and near the airfield and depredation
462 activities that are beyond a standard BASH Plan administered by the Wing Flight Safety office;
- 463 • wetlands, state-listed species, candidate species for federal protection, or unique habitats — those
464 providing essential loafing, nesting, or foraging areas for migratory birds, bats, or other
465 state/federally protected wildlife — are present on the installations. These resources are
466 determined in consultation with the USFWS and state fish and wildlife agencies, where these
467 resources require a level of planning and management that can only be addressed by an INRMP.

468 A Category II installation is one that does not meet any of these criteria, in which case an INRMP is not
469 required. The USAF, with concurrence from the USFWS, the state wildlife agency, and any other applicable
470 agencies, determines whether an installation should be designated as a Category I or II.

471 In 1996, the USAF and MassWildlife concurred that, on the basis of a Comprehensive Ecological
472 Assessment of HAFB (LEC Environmental Consultants, Inc., 1996) and a subsequent MassWildlife tour
473 of HAFB (attachment 1 with HAFB 2015), the base warranted a Category II status because it was highly
474 developed and did not encompass any significant natural resources. Instead, MassWildlife and the USAF
475 entered into a Memorandum of Agreement for addressing any wildlife management concerns that should
476 arise at HAFB (attachment 2 with HAFB 2015).

477 In 2014, the Category II designation underwent renewed consideration when the National Defense
478 Authorization Act (Public Law [P.L.] 113-66) came up for reauthorization. This launched another request
479 for Category II status, with which MassWildlife concurred; however, the agency indicated that another
480 Memorandum of Agreement for managing HAFB's natural resources would be required, with the agency
481 reserving the right to reconsider its concurrence. MassWildlife's reservation stemmed from ongoing
482 concerns about the federally threatened piping plover (*Charadrius melodus*) and red knot (*Calidris canutus*
483 *rufa*), which occur at 4th Cliff (attachment 2 with HAFB 2015), ~~as well as~~ and species listed as T&E or
484 species of special concern (SSC) in Massachusetts. MassWildlife also indicated the need for HAFB to
485 develop a coastal zone management plan for 4th Cliff to address beach erosion and its potential impacts on
486 threatened species (Metcalf and Eddy | AECOM 2009).

487 Subsequently, the base's Installation Development Plan (IDP) indicated that the base has ongoing needs to
488 improve and/or expand its facilities (HAFB 2017a), and a 2019 bat survey confirmed the presence of the
489 federally threatened northern long-eared bat (*Myotis septentrionalis*) at Sagamore Hill. These mounting
490 concerns culminated in the need to develop an INRMP and conduct an Environmental Assessment for
491 HAFB, the latter is expected to be completed between 2023–2024.

492 **Natural Resources Program Authority**

493 Authority and guidance for the INRMP arises from the Sikes Act; AFMAN 32-7003; Air Force Policy
494 Directive (AFPD) 32-70, *Environmental Considerations in Air Force Programs and Activities* (30 Jul
495 2018); and DoDI 4715.03. Guidance is also provided by several laws, Executive Orders (EOs), and other
496 DoD and USAF Directives and Instructions. The Sikes Act requires that an INRMP be developed in
497 cooperation with the USFWS, the state fish and wildlife department, and any other entities, as appropriate

498 by virtue of the land jurisdictions and resources involved. As such, HAFB developed this INRMP in
 499 cooperation with the USFWS, MassWildlife and, because 4th Cliff encompasses coastal resources, NOAA
 500 Fisheries. Additionally, the Sikes Act requires that the installation review its INRMP annually, and it
 501 requires that every five years the external partners (USFWS, MassWildlife, NOAA Fisheries) conduct a
 502 formal review of the INRMP for operation and effect. The Sikes Act specifies that INRMPs:

- 503 • provide for protection, management, and/or enhancement of wild species (animals and plants) and
 504 the habitats (lands, wetlands) that support them;
- 505 • provide for recreation that involves wildlife and other natural resources, and allow the public
 506 access necessary/appropriate for sustainable use of the installation's natural resources, provided
 507 that access and use is consistent with species' needs, human safety, and military security;
- 508 • integrate and ensure consistency among all the activities conducted under the auspices of the
 509 INRMP;
- 510 • provide for enforcement of applicable natural resource laws; and
- 511 • result in no net loss to the installation's natural resources and lands capacities to support the ~~its~~
 512 military mission.

513 AFMAN 32-7003 outlines the roles and responsibilities of USAF units and personnel charged with natural
 514 (and cultural) resource programming and management, including INRMP approvals, and it provides the
 515 necessary direction and instructions for organizing, developing, and reviewing, updating, and revising the
 516 INRMP. AFMAN 32-7003 requires that revisions to and concurrence with this INRMP must be coordinated
 517 through the HAFB chain of command and internal stakeholders. Likewise, external stakeholders, including,
 518 but not limited to, the three key resource management partners (USFWS, MassWildlife, and NOAA
 519 Fisheries), must be provided an opportunity participate in the annual review process and to review
 520 significant updates in draft form.

521 AFD 32-70 discusses general approaches to environmental-quality issues, including proper cleanup of
 522 polluted sites, compliance with applicable regulations, conservation of natural resources, and pollution
 523 prevention.

524 DoDI 4715.03 establishes ~~new~~ ~~new~~ and updated policy and assigns roles for ensuring compliance with all
 525 applicable regulations pertaining to natural resources (and cultural resources potentially affected by natural
 526 resource management). This includes federal, state, and local statutes and regulations; EOs; and
 527 instructions, directives, policies, and/or memoranda issued by United States (U.S.) Presidents, the DoD,
 528 USAF, and HAFB for the integrated management of natural resources on DoD lands. It also outlines
 529 procedures for developing, implementing, and evaluating effectiveness of the base's natural resources
 530 management program, including metrics for assessing the program's overall health and trends. Lastly, DoDI
 531 4715.03 details the installation's obligation to submit annual reports to the Assistant Secretary of Defense
 532 for Energy, Installations, and Environment on the status of INRMP implementation, including projects,
 533 federally-listed species and critical habitats, ecosystem integrity, fish and wildlife management, public use,
 534 and adequacy of the natural resources team and partnership effectiveness for INRMP implementation and
 535 its impact on the base's missions.

536 Section 14.0 of this INRMP, [Appendix A. Annotated Summary of Key Legislation Related to Design and](#)
 537 [Implementation](#), summarizes key legislation and guidance used to create and implement this INRMP. Refer
 538 to the complete listing of Air Force Instructions (AFIs), AFMANs, AFPDs, DoDIs, U.S.C.s, and items
 539 published in the Federal Register to ensure that all applicable guidance documents, laws, and regulations

540 are reviewed. Installation-specific policies, including state and local laws and regulations are summarized
 541 in the table below ([Table 1-1](#)).

542 **1.4 Integration with Other Plans**

543 This INRMP and any other plans potentially affecting natural resources at HAFB are mutually supportive
 544 and do not conflict with each other. In accordance with AFMAN 32-7003 and AFI 32-1015, *Integrated*
 545 *Installation Planning* (30 Jul 2019, Incorporating Change 1, 13 Oct 2020, Corrective Action 4 Jan 2021),
 546 this INRMP shall serve as a key component of HAFB’s IDP (HAFB 2017a). With a vision timeframe of
 547 20–30 years (2037–2047), the IDP covers all aspects of development and improvement to maximize its
 548 capabilities for office, laboratory/research, medical, and housing facilities; distribution and/or storage
 549 systems for water, sewage, energy, and transportation; and other needs for achieving the base’s military
 550 missions. It provides the background and rationale for the base’s policies and programming decisions, and
 551 it identifies constraints to its military missions related to land use, resource conservation, facilities and
 552 infrastructure development, and operations and maintenance to ensure that they meet current needs and
 553 provide for future improvements and expansion. This INRMP identifies natural resources that need to be
 554 considered and incorporated into the base’s IDP and any other plans developed to support future decisions
 555 about installation development.

556

Table 1-1. List of state and local laws and policies relevant to Hanscom Air Force Base.

Installation-Specific Policies (including State and/or Local Laws and Regulations)	
Massachusetts Endangered Species Act (MESA) of 1990 (Massachusetts General Law, Title XIX, c.131A, as amended)	Uses the same definitions for T&E species as the federal Endangered Species Act of 1973, as amended; defines species of special concern and what constitutes “take” of state-listed animal and plant species; defines and regulates activities in designated “Priority Habitat” and “Estimated Habitat” (see Section 2.3.4, Threatened and Endangered Species and Species of Concern , for details).
Massachusetts Wetland Protection Act (Massachusetts General Laws, Title XIX, Chapter 131, Section 40), as amended	Protects wetlands and their benefits to the public (e.g., flood control, protection of water supplies, fish and wildlife habitat); to protect these interests, a careful review is required for any proposed activities that could affect wetlands; includes not only wetlands, but also floodplains, riverfronts, and land under any type of water body, from inland waterways to the ocean” (see https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXIX/Chapter131/Section40).
Massachusetts Rivers Protection Act (1996 Mass. Acts Chapter 258)	Protects Massachusetts’ rivers and streams, and the lands adjacent to them; the purpose of the act is to protect private and public water supplies and groundwater and prevent pollution; to provide flood control and prevent storm damage; and to protect fish and wildlife and habitats. The act also encourages the establishment of open spaces alongside rivers and streams to help ensure their protection (see https://archives.lib.state.ma.us/bitstream/handle/2452/30374/1996acts0258.pdf).

<p>Massachusetts Coastal Management Program</p>	<p>Protects the Massachusetts coastal zone, in support of the federal Coastal Zone Management Act. Defines the state coastal zone and requires a federal consistency review for any federal actions taking place within the coastal zone. The Massachusetts Office of Coastal Zone Management determines whether the “coastal effects” of federal actions are consistent with the state’s coastal policies. See (https://www.mass.gov/orgs/massachusetts-office-of-coastal-zone-management-czm) and Section 7.13.</p>
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559 Additionally, this INRMP is integrated with the HAFB Landscape and Grounds Maintenance Plan (HAFB
560 2020b), the HAFB Pest Management Plan (PMP) (HAFB 2020c), the HAFB Snow and Ice Control Plan,
561 the Stormwater Management Plan, and the Integrated Cultural Resources Management Plan, ~~as well as~~
562 ~~the~~and the USAF EIAP (AFMAN 32-7003). The installation Natural Resource Manager (NRM) will
563 collaborate with any action proponent and the installation EIAP manager to ensure that activities potentially
564 affecting natural resources are fully considered and in compliance with the National Environmental Policy
565 Act (NEPA).

566 This INRMP integrates with the base’s PMP, which provides a framework and assigns/describes roles and
567 responsibilities for addressing undesirable or harmful animals (including invertebrates and vertebrates) and
568 plants. It outlines the program elements of pest management, ranging from human health and environmental
569 safety to pest management and protocols associated with pesticide storage/transport, use, disposal, and
570 recordkeeping needs/protocols. In concert with this INRMP, the PMP ensures that pests are managed in a
571 manner that protects not only human health and safety, but also environmental health.

572 The Landscape and Grounds Maintenance Plan stipulates requirements and protocols for landscape
573 maintenance activities on the improved, semi-improved, and unimproved grounds at HAFB and its GSUs.
574 As such, the integration of the INRMP and the Landscape and Grounds Maintenance Plan ensures that they
575 are mutually supportive and do not conflict with each other. The office of primary responsibility for the
576 Landscape and Grounds Maintenance Plan is the 66th Air Base Group (66 ABG) Civil Engineer (CE)
577 Operations Flight, Heavy Repair Element (66 ABG/CEOH).

578 **2.0 INSTALLATION PROFILE**

Table 2-1. Background information on Hanscom Air Force Base contacts and natural resources.

Office of Primary Responsibility	66 ABG/Civil Engineering has overall responsibility for implementing the natural resources management program and is the lead organization for monitoring compliance with applicable federal, state, and local regulations.
Natural Resources Manager/Point of Contact	Mr. Scott Sheehan Natural Resources Manager 66 ABG/CEIE, Bldg 1810 120 Grenier Street, Bldg 1810 Hanscom AFB, MA 01731-1910 (781) 367-7168 scott.sheehan.1@us.af.mil
State and/or local regulatory Points of Contact (include agency name for Sikes Act cooperating agencies)	<p><u>Signatories:</u></p> <p>Audrey Mayer, Ph.D. Supervisor, New England Field Office U.S. Fish and Wildlife Service 70 Commercial Street, Suite 300 Concord, New Hampshire 03301-5094 (603) 496-5181 audrey_mayer@fws.gov</p> <p>Send also to central email inbox: newengland@fws.gov</p> <p>Eve Schlüter, Ph.D. Assistant Director Natural Heritage & Endangered Species Program Massachusetts Division of Fisheries & Wildlife 1 Rabbit Hill Road, Westborough, MA 01581 eve.schluter@mass.gov</p> <p>Michael Pentony Regional Administrator Greater Atlantic Regional Fisheries National Marine Fisheries Service 55 Great Republic Drive Gloucester, Massachusetts 01930 michael.pentony@noaa.gov</p> <p><u>Regulator POCs:</u></p> <p>Katherine Ineson, PhD Regional Military Lands Partnership Coordinator U.S. Fish and Wildlife Service 70 Commercial Street, Suite 300 Concord, New Hampshire 03301-5094 (540) 553-4337</p>

	<p>katherine_ineson@fws.gov</p> <p>Amy Hoenig Endangered Species Review Biologist Natural Heritage & Endangered Species Program Massachusetts Division of Fisheries & Wildlife 1 Rabbit Hill Road, Westborough, MA 01581 (508) 389-6364 amy.hoenig@mass.gov</p>
Total acreage managed by installation	934
Total acreage of wetlands	35.08
Total acreage of forested land	180
Does installation have any Biological Opinions? (If yes, list title and date, and identify where they are maintained)	No Biological Opinions as of 2023
<p>Natural Resources Program Applicability (Place a checkmark next to each program that must be implemented at the installation. Document applicability and current management practices in Section 7.0, NATURAL RESOURCES PROGRAM MANAGEMENT)</p>	<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Fish and Wildlife Management <input checked="" type="checkbox"/> Outdoor Recreation and Access to Natural Resources <input type="checkbox"/> Conservation Law Enforcement <input checked="" type="checkbox"/> Management of Threatened, Endangered, and Host Nation-Protected Species <input checked="" type="checkbox"/> Water Resource Protection <input checked="" type="checkbox"/> Wetland Protection <input checked="" type="checkbox"/> Grounds Maintenance <input checked="" type="checkbox"/> Forest Management <input type="checkbox"/> Wildland Fire Management <input type="checkbox"/> Agricultural Outleasing <input checked="" type="checkbox"/> Integrated Pest Management Program <input type="checkbox"/> Bird/Wildlife Aircraft Strike Hazard <input checked="" type="checkbox"/> Coastal Zone and Marine Resources Management <input checked="" type="checkbox"/> Cultural Resources Protection <input checked="" type="checkbox"/> Public Outreach <input checked="" type="checkbox"/> Geographic Information Systems

579

580 **2.1 Installation Overview**

581 **2.1.1 Location and Area**

582 Hanscom AFB is an 846-acre installation located in Middlesex County, Massachusetts, about 18 miles
 583 northwest of Boston (Table 2-2, Figure 2-1, and Figure 2-2). Approximately 713 acres of the installation
 584 are developed, 101 acres are semi-improved or forested, and 31 acres are composed of wetland areas.
 585 Additionally, a section of the Shawsheen River runs through the northern edge of the base. HAFB manages
 586 two GSUs: 4th Cliff and Sagamore Hill. The 4th Cliff annex is a 56-acre section of the Humarock Peninsula
 587 in Scituate, approximately 40 miles southeast of the main base (Figure 2-3). Sagamore Hill is a 32-acre
 588 annex in Hamilton, approximately 25 miles northeast of the main base (Figure 2-4) HAFB also operates
 589 the Patriot Golf Course on the Edith Nourse Veterans Administration Hospital in Bedford, MA (Figure
 590 2-5).

591 The main base borders the historic towns of Lincoln, Bedford, and Lexington and is about four miles east
 592 of the town of Concord (Figure 2-1). The surrounding areas are composed of primarily developed
 593 residential and commercial land interspersed with fragments of upland forest and wetlands, which are
 594 preserved for conservation, recreational opportunities, and to provide clear lines of sight for radar testing
 595 and flight operations at Hanscom Field, a civil airport located directly north of HAFB. Mission activities at
 596 HAFB focus on the life cycle management of aircraft weapons systems and technology, and they take place
 597 almost entirely within the 413 administrative and laboratory facilities on base (HAFB 2017a).

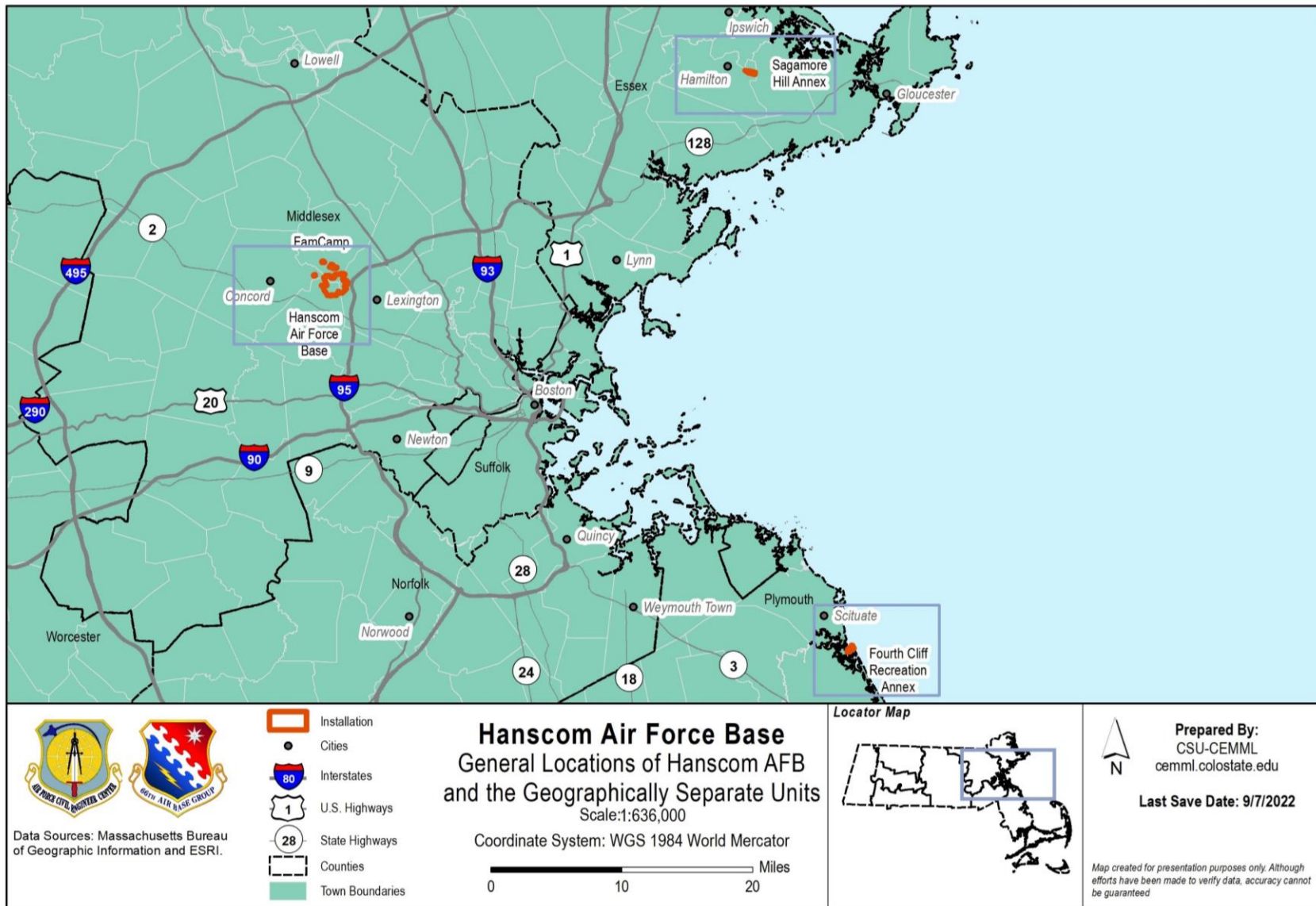
Table 2-2. Installation/geographically separate unit locations and area descriptions.

Installation/ Geographically Separated Unit	Main Use / Mission	Acreage	Addressed in INRMP?	Describe Natural Resource Implications
Hanscom Air Force Base	Headquarters for 66th Air Base Group / Provides support for the Air Force Life Cycle Management Center and Air Force Materiel Command, and provides quality-of-life opportunities for military personnel, family members, and Team Hanscom workers	846	Addressed throughout INRMP	Development related to the mission has resulted in highly fragmented wetland and forested areas. Further development has the potential to further reduce these areas and the important buffers they create. Pollution from traffic associated with reduced air quality.
Fourth Cliff Recreation Annex	Provide high quality opportunities for outdoor recreation	56	Addressed throughout INRMP	This annex is highly reliant on the upland section of the Humarock Peninsula for recreation and lodging, which is under threat from erosion. Visitors have the potential to disturb wildlife, including T&E species and SSC.

Table 2-2. Installation/geographically separate unit locations and area descriptions.

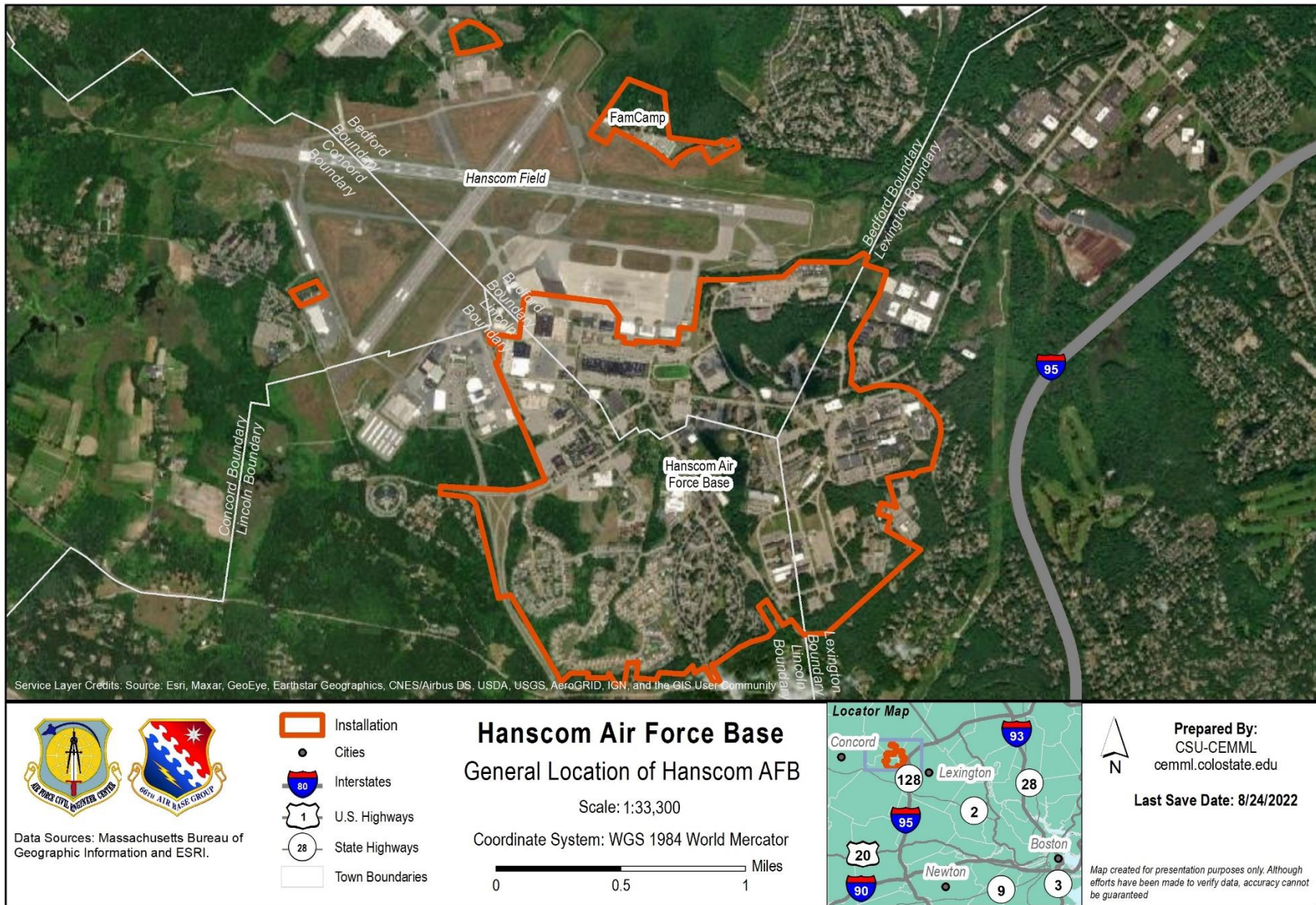
Installation/ Geographically Separated Unit	Main Use / Mission	Acreage	Addressed in INRMP?	Describe Natural Resource Implications
Sagamore Hill Solar Observatory Annex	Deliver timely, relevant, and specialized environmental intelligence for the planning and execution of USAF missions	32	Addressed throughout INRMP	Mission activities at this annex are limited to 3 of 32 acres; the remaining 29 acres comprise forests and wetlands that are largely unaffected by current efforts.
Patriot Golf Course	HAFB operated recreation for DoD, installation, and VA personnel and dependents, and their guests. The Patriot Golf Course is on property owned by the Veterans Administration and is permitted to the USAF	TBD	The Veterans Administration and the USAF will clarify natural resource responsibilities as an objective of this INRMP	

598



599

600 Figure 2-1. General location of Hanscom Air Force Base and the geographically separated units under its administration.



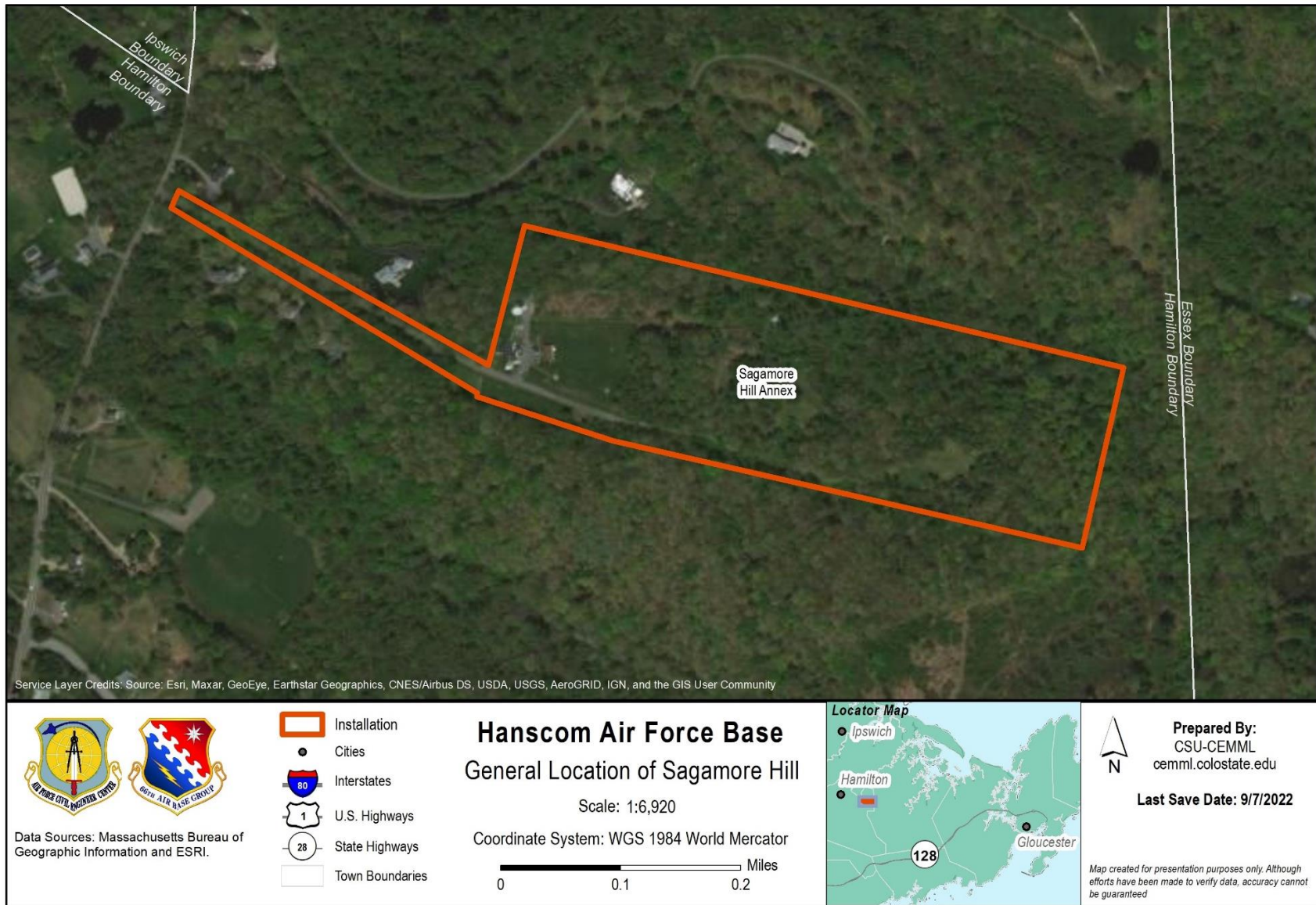
601

602 Figure 2-2. General location of Hanscom Air Force Base.



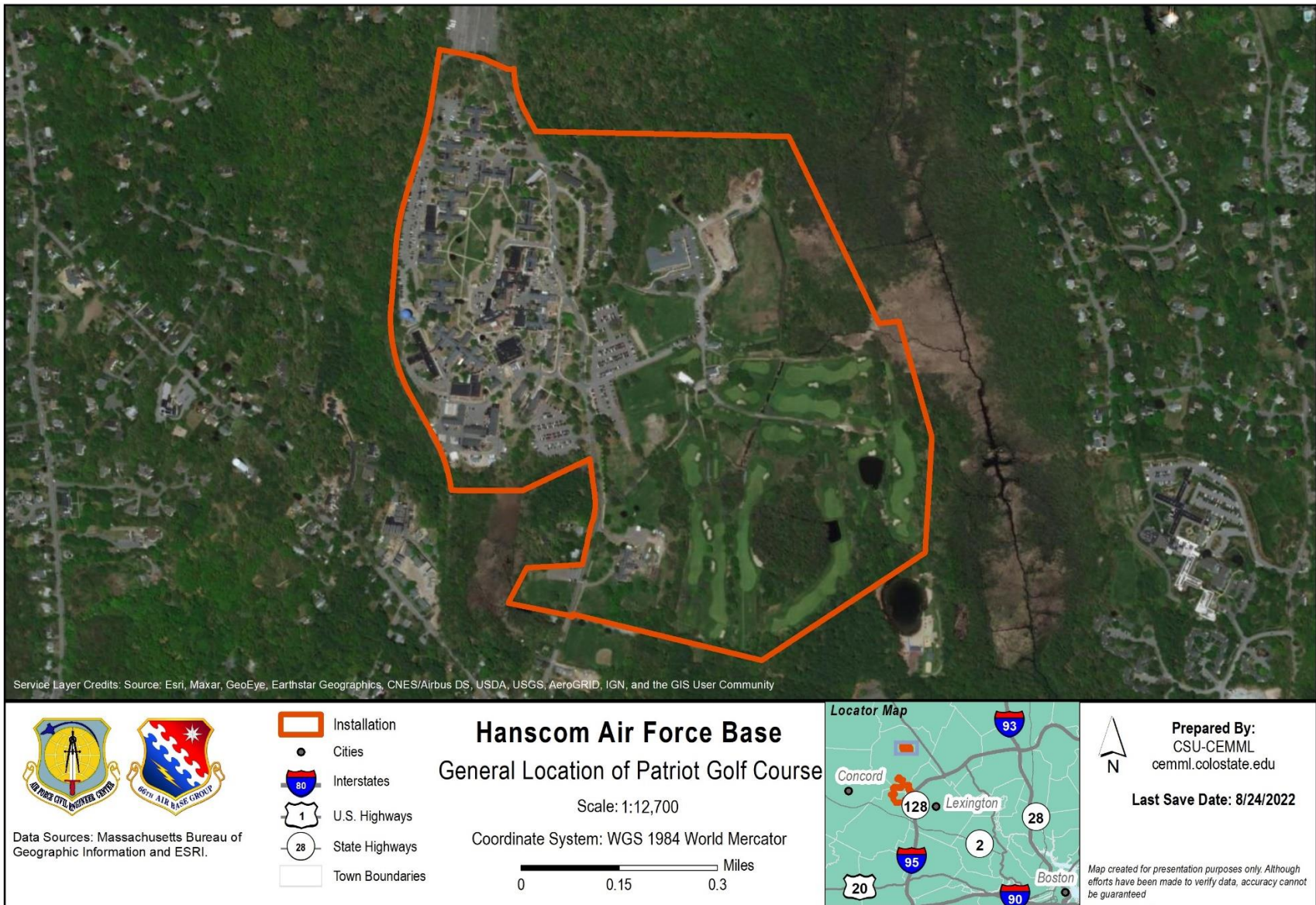
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604 Figure 2-3. General location of the Fourth Cliff Recreation Annex



605

606 Figure 2-4. General location of Sagamore Hill Solar Weather Observatory.



607
 608

Figure 2-5. General location of Patriot Golf Course.

609 2.1.2 *Installation History*610 **Hanscom Air Force Base**

611 Hanscom AFB was established in May 1941 when the Commonwealth of Massachusetts acquired 500 acres
 612 of undeveloped land composed of mainly upland forest and wetlands bordering the towns of Bedford,
 613 Lincoln, and Lexington. Originally named the Boston Auxiliary Airport at Bedford, it was developed in
 614 anticipation of the United States' entry into World War II. Following the attack on Pearl Harbor in 1941,
 615 the land was leased to the War Department, and the airport was quickly developed into an active military
 616 installation. The installation was first actively used in 1942 when the 85th and 318th Fighter Squadrons
 617 used the site to train with the Curtiss P-40 Warhawk before they were deployed to North Africa and Europe.
 618 In 1943, the airport was renamed Laurence G. Hanscom Field in honor of a Massachusetts-born pilot and
 619 reporter, Laurence Gerard Hanscom (1906–1941). Hanscom was active in early aviation and involved in
 620 founding the Massachusetts Civil Air Reserve. He worked for the 'Worcester Gazette and Telegraph' when
 621 he was killed in the crash of his Fleet biplane while lobbying for the establishment of the Boston Auxiliary
 622 Airport.

623 As World War II approached its conclusion, the focus of Hanscom Field transitioned from combat training
 624 to testing radar technology developed by the Massachusetts Institute of Technology (MIT) Radiation
 625 Laboratory and by the Harvard Radio Research Laboratory. In 1947, an additional 600 acres of land were
 626 acquired by the USAF and added to Hanscom Field to provide open space for radio testing activities. At
 627 this point in time, the installation's primary mission was to further support the development of Command,
 628 Control, Communications, and Intelligence systems by recruiting scientists and engineers into the newly
 629 formed USAF Cambridge Research Laboratories (HAFB 2019a). What follows is an outline of
 630 development and activities at Hanscom Field and, later, HAFB.

631 1950s

- 632 • Hanscom Field developed new facilities and expanded existing facilities and infrastructure to
 633 further support MIT's Lincoln Lab development and testing of advanced air defense systems.
- 634 • The 6520th Test Support Wing provided testing and evaluation support for development of the
 635 Cape Cod experimental air defense system.
- 636 • The Air Defense Systems Management Office was established at Hanscom Field with support
 637 detachments from the Air Research and Development Command, the Air Force Materiel
 638 Command (AFMC), and the Air Defense Command.
- 639 • The Cambridge Research Laboratories migrated to their own facilities outside of Hanscom Field.

640 1960s

- 641 • The Electronic Systems Division was established with the combined resources of the Air
 642 Research and Development Command and the AFMC. The Electronic Systems Division operated
 643 as the primary host unit at Hanscom Field to support the mission of developing air defense
 644 technology. In 1961, the "Cape Cod" prototype was further developed into the Semi-Automated
 645 Ground Environment system, which revolutionized USAF air defense capabilities and contributed
 646 significantly to advances in air traffic-control systems.
- 647 • The USAF Command and Control Development Division assumed control of all research and
 648 development on Hanscom Field, and the Electronic Supply Center was activated to expand and
 649 manage the production of USAF control systems.

- 650 •

651 1970s

- 652 • In 1973, all flying operations at Hanscom Field were replaced entirely by the research and
653 development of advanced air technology and systems.
- 654 • In 1974, ownership of the runway and flight line sections of the base was transferred to the
655 Commonwealth of Massachusetts. This land is still called Hanscom Field and operates as a
656 civilian airport under Massport.
- 657 • Hanscom Field was officially designated as Hanscom Air Force Base in 1977.

658 1980s

- 659 • The Electronic Systems Division’s development and testing capabilities were expanded with the
660 construction of four new systems-management engineering facilities. Base support services were
661 also expanded with the addition of new medical and family support centers.
- 662 • Throughout the 1980s, the Electronic Systems Division developed many landmark Command,
663 Control, Communications, and Intelligence systems, including the Airborne Warning and Control
664 System, the Strategic Defense Initiative, and the Joint Surveillance Target Attack Radar System.

665 1990s

- 666 • The Electronic Systems Division was renamed the Electronics Systems Center and was
667 reorganized under the AFMC to become the Air Force Center of Excellence for Command,
668 Control, Communications, Computers, and Intelligence.
- 669 • In 1997 multiple research facilities on HAFB were provided for the Air Force Research
670 Laboratory Sensors Directorate and the Space Vehicles Directorate.

671 2000s

- 672 • The Electronic Systems Center was reorganized into three Program Executive Offices that were
673 supported by the 66 AGB to further consolidate the research and development efforts.

674 2010s

- 675 • Laboratory presence on HAFB was reduced with the departure of the Air Force Research
676 Laboratory Sensors Directorate and the Space Vehicles Directorate.
- 677 • The Electronic Systems Center was realigned to become part of the newly established Air Force
678 Life Cycle Management Center (AFLCMC).
- 679 • The current mission of HAFB is to provide support to the AFLCMC and MIT Lincoln Laboratory
680 for the research and life cycle management of USAF Command, Control, Communications,
681 Computer, and Intelligence systems.

682 **Fourth Cliff Recreation Annex**

683 The 4th Cliff annex began as a life-saving station built onto the northern tip of the Humarock Peninsula. In
684 1918, the peninsula was the site of a Navy Radio Compass Station before being used as a summer resort
685 throughout the 1920s and 1930s. When the U.S. began preparing for World War II, the U.S. Army started
686 developing a coastal defense system, which included an artillery battery at 4th Cliff that became essential
687 in the Southern Strategic Defense of Boston Harbor. To conceal the artillery defense system, the military
688 facilities and watchtowers on 4th Cliff were developed to look like normal additions to the cottage and
689 resort community that were already present. New construction included an underground bunker and fire
690 control tower and station.

691 In 1948, control of 4th Cliff was granted to the USAF to develop a Field Station. The station was used to
692 test submarine communication technology until 1966, when all Navy ~~activities were~~ activities ceased,
693 and 4th Cliff was annexed to Hanscom Field. Throughout the 1970s and 1980s, most of the original facilities
694 were removed and replaced with new cottages and recreational facilities. The 56-acre site is now used solely
695 for recreation by military personnel and their families (66th Force Support Squadron [66 FSS] 2021). With
696 its unique location on the confluence of the North and South Rivers, the site provides diverse habitat for
697 avian, mammalian, and marine species, including several federal- and state-listed species.

698 **Sagamore Hill Solar Weather Observatory Annex**

699 Sagamore Hill was established in 1966 under the USAF Geophysics Laboratory as part of a worldwide
700 effort to monitor space weather events that may interfere with U.S space operations. Multiple observation
701 stations were developed on the site to provide radio astronomy data for civilian and government agencies.
702 Many of the observatory facilities were removed throughout the 1970s and operations were further reduced
703 in 1978, when ownership was transferred to the USAF, and the remaining facility was placed under the
704 control of the 557th Weather Wing. Afterwards, the use of Sagamore Hill was narrowed to focus solely on
705 monitoring solar events and patterns that may affect the USAF radio infrastructure (Guidice 1979).
706 Currently, Sagamore Hill provides support to the Electronic Systems Center Program Executive Offices to
707 broaden and enhance its global solar observation capacity (HAFB 2017a). There are a few abandoned
708 structures on the site that are now overgrown with vegetation, in addition to the maintained buildings and
709 antenna structures.

710 *2.1.3 Military Missions*

711 The primary mission of HAFB is to support the AFMC, which is responsible for establishing the
712 infrastructure, workforce, and resources necessary to provide the USAF with war-winning expeditionary
713 capabilities and personnel. HAFB supports the AFMC by managing the research and life-cycle
714 development of USAF Command, Control, Communications, Computer, and Intelligence systems through
715 two host units: the AFLCMC and the 66 ABG. The AFLCMC is the unit directly responsible for the
716 logistical and life-cycle management support of research and development projects on and off HAFB. The
717 66 ABG provides support to the AFLCMC by managing HAFB's land and assets and its personnel. HAFB
718 also fulfills an additional research role for Command, Control, Communications, Computer, and
719 Intelligence systems through the MIT Lincoln Laboratory, which uses the base and its facilities to research
720 advanced aircraft systems.

721 The following subsections detail HAFB's units and their missions.

722 *Air Force Life Cycle Management Center*

723 The AFLCMC is one of six centers that operate under the AFMC and has the primary mission of managing
724 the development, testing, and life cycle development of USAF weapons systems and technology. The
725 AFLCMC is organized into the three Program Executive Offices responsible for (1) Command, Control,
726 Communications, Intelligence, and Networks; (2) Battle Management; and (3) Nuclear Command, Control
727 and Communications Integration Directorate. Life cycle management includes organizing and executing
728 the development of weapons systems to reduce redundancy and increase the efficiency of production and
729 testing from the beginning of systems discovery to testing and implementation.

730

731 ***66th Air Base Group***

732 The primary mission of the 66 ABG is to provide logistical and management support for the 10,306 active-
 733 duty, reserve, and civilian contractors that work on HAFB and the 130,000 retired personnel that live within
 734 New England and New York. The 66 ABG also supports the AFLCMC by maintaining and managing the
 735 HAFB environment, personnel, and facilities, which is accomplished through several units of the 66 ABG,
 736 some of which are described below. A full list of 66 ABG units is available at
 737 <https://www.hanscom.af.mil/Units/>

738 ***66th Medical Squadron***

739 The 66th Medical Squadron provides a variety of on-site medical services for past and present USAF
 740 personnel and their families. These services include basic medical care, optometry, mental health support,
 741 immunizations, and dental care.

742 ***66th Security Forces Squadron***

743 The 66th Security Forces Squadron provides internal law enforcement, community policing, and firearm
 744 regulation on HAFB. It is also responsible for managing HAFB gates and ensuring that transportation and
 745 firearm laws and regulations are followed to ensure the safety of all on the base.

746 ***66th Civil Engineering Division***

747 The 66th Civil Engineering Division (66 CED) provides a wide array of installation support services to
 748 maintain and manage the installation's environment and assets. The 66 CED has five internal groups that
 749 specialize in different sections of base management to ensure that HAFB operates efficiently and provides
 750 access to the facilities and technology needed by the AFLCMC. The Fire Emergency Services unit focuses
 751 on providing rapid emergency response for fire and reducing the impacts and potential for mission-altering
 752 fire events. The Installation Management unit provides financial and oversight support for management of
 753 all technology, installations, and facilities present on the base; this unit also provides logistical planning
 754 and GIS information for all community-planning and construction efforts undertaken by the 66 ABG on
 755 HAFB. The Operations unit provides oversight and management support for the customer service
 756 infrastructure, contract management, and all maintenance and engineering efforts. The Installation Office
 757 of Emergency Management provides oversight and training for all HAFB emergency response operations
 758 and incident management.

759 ***66th Force Support Squadron***

760 The primary mission for the 66 FSS is to provide organization and access to the recreation, career
 761 development, event planning, lodging, and community services offered on HAFB. It serves as the public
 762 component of the 66 ABG by ensuring that all cultural, social, and physical needs of USAF personnel are
 763 met on the installation.

764 **Major Associate Tenants**

765 ***Massachusetts Institute of Technology Lincoln Laboratory***

766 The MIT Lincoln Laboratory is tasked with the development and testing of new and advanced technology
 767 in the fields of intelligence, tactical systems, air traffic control, engineering, communications, and missile
 768 defense. HAFB serves as the headquarters for research and development supported by the Lincoln Space
 769 Surveillance Complex in Westford, Massachusetts, and two large testing sites in the Marshall Islands and
 770 New Mexico (HAFB 2020d).

771 **Massachusetts National Guard Joint Force Headquarters**

772 The primary mission of the Massachusetts National Guard Joint Force Headquarters on HAFB is to manage
 773 and support all deployed and reserve National Guard personnel in Massachusetts. It also serves as an
 774 important point of contact and communication between National Guard personnel and combatant
 775 commanders.

Table 2-3. Hanscom Air Force Base major tenants and natural resources responsibility.

Tenant Organization	Natural Resources Responsibility
MIT Lincoln Laboratory	66th Civil Engineering Division
Massachusetts National Guard	66th Civil Engineering Division

776

777 **2.1.4 Natural Resources Needed to Support the Military Mission**

778 **Hanscom Air Force Base**

779 The HAFB mission of supporting research and development of air traffic control and weapons systems is
 780 not directly tied to natural resources, but the natural areas on the base provide essential support functions.

781 Open sky is required for transmission activities in multiple areas of HAFB, including the Hanscom Field
 782 runway apron on the northern section of the base, and the AFLCMC on the northeastern section. There are
 783 also three remote target areas used by the MIT Lincoln Laboratory that require an open site line from their
 784 facility on the main base to ensure equipment testing and research and development activities can continue.
 785 Open land is needed to prevent equipment interference with these programs. Specifically, open land is
 786 needed in the soccer field and adjacent parking lot.

787 HAFB requires stable soils to protect installation facilities and the roads that provide access throughout
 788 the base. Although erosion has not been a problem, when it does occur, erosion mitigation efforts include
 789 plantings of grasses and shrubs on developed areas of the base to improve soil stability and limit the
 790 presence of bare soils. Cover in these areas is composed primarily of a preferred seed mix developed for
 791 HAFB, consisting of perennial ryegrass (*Lolium perenne*), fescue grasses (*Festuca* spp.), and Kentucky
 792 bluegrass (*Poa pratensis*, variety not stated) (HAFB 2020b). Wetland areas conserved around the Shawsheen
 793 River support the mission by providing a buffer from flooding events that could negatively affect the soils
 794 and structures of HAFB (HAFB 2010a).

795 Natural resources also play a critical role in supporting on-site recreation programs and activities. These
 796 programs provide opportunities to improve and maintain the social and physical wellbeing of HAFB
 797 personnel and their families, which is essential for an efficiently run base (HAFB 2017a).

798 **Fourth Cliff Recreation Annex**

799 As a result of 4th Cliff’s unique location on the edge of a peninsula, the site depends on soil stability to
 800 support its mission. The peninsula is bounded by four cliffs that have been eroding at the rate of one foot
 801 per year since erosion-mitigation efforts began in the 1950s. If the effects of erosion are not mitigated, there
 802 will be a continued threat to 4th Cliff’s roads and facilities (HAFB 2014). Natural resources also support
 803 the education programs at 4th Cliff. The GSU has access to sandy beach, tidal flat, and marsh environments
 804 used by a variety of animals, including the federally threatened piping plover and least tern.

805 **Sagamore Hill Solar Weather Observatory Annex**

806 The primary mission of Sagamore Hill is fulfilled with the radar and two observatory facilities located on
 807 the western end of the site. Stable ~~soils are~~soil is necessary for Sagamore Hill’s mission to ensure access
 808 throughout the annex and reduce erosion damage to the facilities and roads. The site’s mission also requires
 809 open space around the solar weather-monitoring equipment and the surrounding region to ensure maximum
 810 solar-observation capabilities (HAFB 2017a).

811 *2.1.5 Surrounding Communities*

812 Middlesex County has a population of about 1.6 million — one of the largest county populations in in the
 813 country. The most prominent sectors of the Middlesex County economy are healthcare, education, technical
 814 services, and manufacturing (United States Census Bureau 2019). The towns and communities adjacent to
 815 HAFB include Bedford, Lexington, Lincoln, and Concord, accounting for approximately 70,000 people.
 816 With an active work ~~force~~force of about 10,306 personnel (HAFB 2017a), HAFB is one of the main
 817 economic drivers for communities surrounding Boston. By 2030, the population of nearby towns is
 818 expected to increase by approximately six percent, but each of these towns encompass many historical
 819 landmarks from the Revolutionary War, which reduces the level of potential development in a large portion
 820 of the area surrounding the installation. As such, the increasing population and residential development is
 821 unlikely to have any major impact on HAFB’s mission.

822 With the primary industries in the surrounding towns being technical services, manufacturing, health care,
 823 and education, the developed areas surrounding HAFB are composed primarily of residential communities
 824 and commercial facilities. Hanscom Field, currently a civil airport operated by ~~the Massport~~Massport, lies
 825 immediately north of HAFB. That land is heavily developed with runways and a clearance area to provide
 826 open airspace for incoming and outgoing aircraft.

827 The undeveloped areas surrounding HAFB are similar in composition to the natural areas on base, a
 828 majority of which ~~is~~are small, fragmented sections of forest and wetlands, including small bodies of open
 829 water. Agricultural and natural resource-related land use account for less than two percent of the
 830 surrounding community’s economic output; in fact, only 10 percent (19,000 acres) of the land in all of
 831 Middlesex County is agricultural (United States Census Bureau 2019).

832 *2.1.6 Local and Regional Natural Areas*

833 The composition of areas surrounding HAFB are developed for residential and commercial use, with some
 834 scattered, undeveloped forest fragments, wetlands, rivers, and ponds. There are several major nearby natural
 835 areas encompassed by conservation areas and important historical sites, as described ~~below~~below, and
 836 depicted in [Figure 2-6](#).

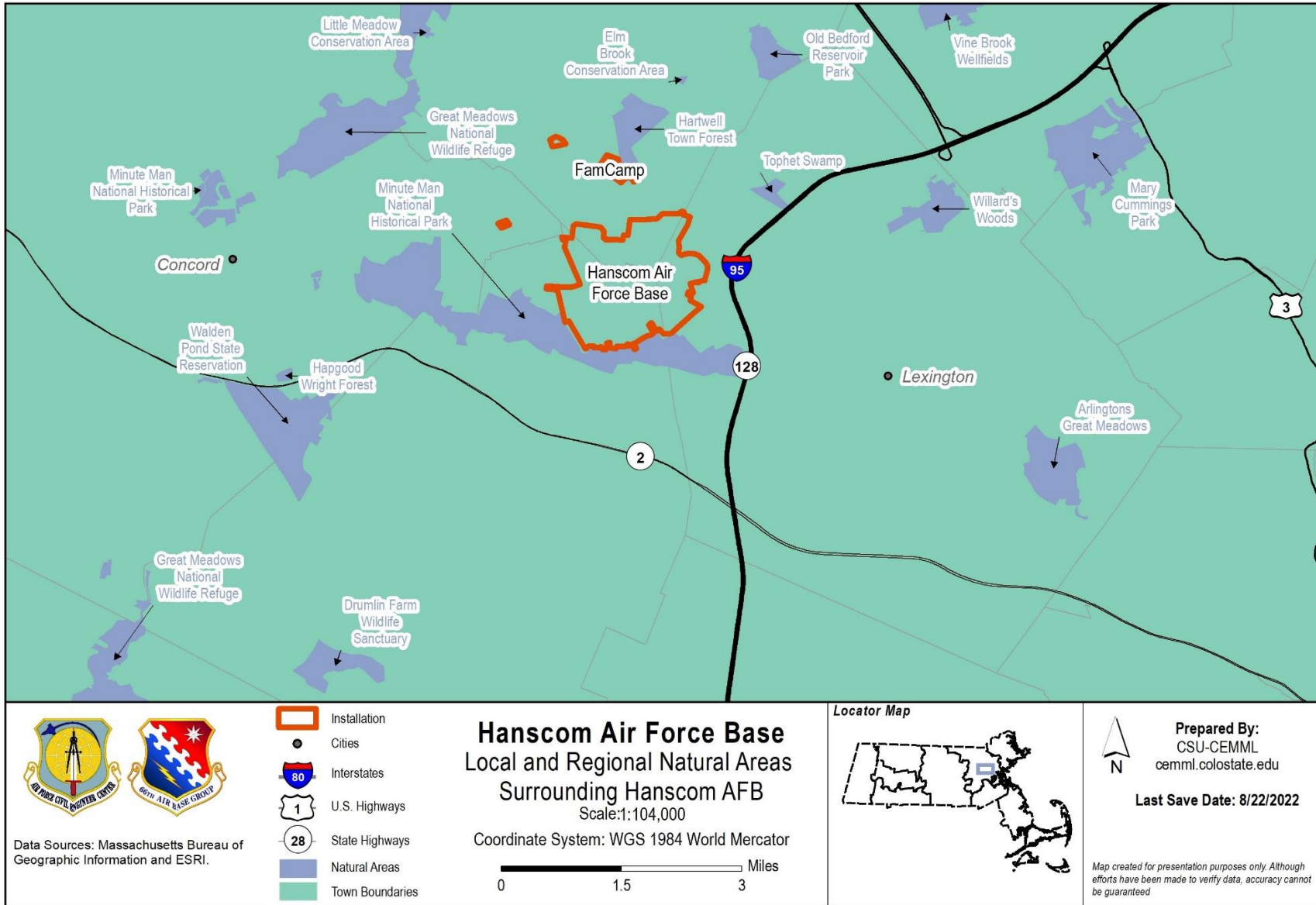
- 837 • Minute Man National Park — This unit of the National Park Service is located south of HAFB in
 838 Concord. It was created to preserve the area surrounding Battle Road, which was the site of a
 839 battle between the Minutemen and the British on 19 April 1775. In addition to natural areas
 840 composed of wetlands and forest, this park includes a variety of historical markers from other
 841 battles and the site of Paul Revere’s capture.
- 842 • Walden Pond State Reservation — This forested area, located two miles southwest of HAFB, is
 843 the historical site of David Thoreau’s cabin. The reservation also provides opportunities for
 844 public hiking, swimming, and fishing.

- 845 • Great Meadows National Wildlife Refuge — This refuge, located northwest of HAFB, was
846 created to preserve a large wetland and forested areas and to provide an undisturbed natural
847 environment for the public (HAFB 2010a).

848 There are 13 additional natural areas within five miles of HAFB that are used primarily for recreation and
849 to preserve small, yet essential, habitats. The parks are composed of landscaped grasses and shrubs, whereas
850 the conservation areas and sanctuaries are composed of small wetland and forest habitats similar to those
851 found on HAFB. These smaller sites are listed below.

- 852 • Little Meadow Conservation Area
- 853 • Hartwell Town Forest
- 854 • Hapgood Wright Forest
- 855 • Mill Pond Conservation Area
- 856 • Drumlin Farm Wildlife Sanctuary
- 857 • Cat Rock Park
- 858 • Arlington’s Great Meadows
- 859 • Willard’s Woods
- 860 • Mary Cummings Park
- 861 • Vine Brook Wellfields
- 862 • Old Bedford Reservoir Park
- 863 • Tophet Swamp
- 864 • Elm Brook Conservation Area

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865
866

Figure 2-6. Location of local and regional natural areas surrounding Hanscom Air Force Base.

867 2.2 *Physical Environment*

868 2.2.1 *Climate*

869 HAFB's general climate is dictated by its location at the transitional zone between the Humid Hot Summer
870 Continental Climate to the south and the Humid Warm Summer Continental Climate to the north and is
871 characterized by cold, snowy winters followed by warm growing seasons and hot summers. ~~The~~
872 Massachusetts' coastal environment is moderated by the Atlantic Ocean and has a subtropical or oceanic
873 climate, with slightly warmer winters than the rest of the state. Hurricanes and tropical storms of varying
874 size are known to strike the Massachusetts coast at an average rate of one storm every other year. They
875 typically occur during August, September, and the first half of October. The entire state may feel the effects
876 of these storms, although coastal areas are the most susceptible to damage from both high winds and storm
877 surges.

878 Severe winter storms, such as ice storms, nor'easters, and heavy snowstorms, are the most frequently
879 occurring natural hazards in Massachusetts. Coastal areas are most vulnerable to nor'easters, named for the
880 northeasterly winds that bring heavy rain and snow into northeastern coastal areas. Nor'easters can cause
881 coastal flooding, coastal erosion, and hurricane force winds. Snowstorms and ice storms can disrupt
882 transportation, interrupt power, and damage infrastructure (Massachusetts Emergency Management
883 Agency [MEMA] and the Massachusetts Executive Office of Energy and Environmental Affairs [EOEEA]
884 2018).

885 2.2.1.1 **Climate Change Projections**

886 Colorado State University Center for Environmental Management of Military Lands (CSU CEMML;
887 hereafter 'CEMML'; 2022a) developed site-level climate projections for the area encompassing HAFB.
888 CEMML used the U.S. National Center for Atmospheric Research (NCAR) Community Climate System
889 Model (CCM) simulations prepared for the Intergovernmental Panel on Climate Change Fifth Assessment
890 Report (Moss et al. 2007, 2010; Gent et al. 2011; Hurrell et al. 2013). They generated simulations for two
891 Representative Concentration Pathway (RCP) scenarios: a moderate emissions scenario (RCP 4.5) and a
892 higher emissions scenario (RCP 8.5). They used these scenarios to produce time series of daily climate
893 values for the decades centered around 2030 (2026–2035) and 2050 (2046–2055). Data from the CCSM
894 model that had been downscaled to 1/16th of a degree using the LOCA downscaling methodology was used
895 to develop projections for the four future climate scenarios. The variance of climate projections between
896 HAFB and its associated GSUs are insignificant, hence the climate projections below given for the main
897 base are valid for the entirety of HAFB.

898 The results indicate a general trend of increasing temperatures by mid-century (

899

900 Table 2-4). Minimum, maximum, and average annual temperatures are projected to increase under both
901 emissions scenarios and timeframes. Both scenarios project increases in annual average temperature over
902 the historical average by 2030, with an increase of 2.4 °F for RCP 4.5 and 2.6 °F for RCP 8.5. Both
903 emissions scenarios project higher warming by 2050, with RCP 4.5 projecting an increase of 3.3 °F and
904 RCP 8.5 projecting an increase of 3.8 °F. All scenarios show increases in number of days reaching
905 temperatures >90 °F, and reductions in days below 32°F. Precipitation is projected to increase in all but one
906 model scenario.

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909 Table 2-4. Summary of modeled historical and projected climate data for Hanscom AFB.

Variable ¹	Historical	RCP 4.5		RCP 8.5	
		2030	2050	2030	2050
PRECIP (inches)	45.8	47.5	46.6	43.4	46.4
TMIN (°F)	39.0	41.3	42.1	41.5	42.7
TMAX (°F)	60.2	62.6	63.7	63.0	64.0
TAVE (°F)	49.6	52.0	52.9	52.2	53.4
GDD	3084.0	3465.7	3655.0	3522.2	3712.8
HOTDAYS	11.0	23.0	30.0	28.3	30.3
COLDDAYS	139.7	118.9	120.1	123.1	114.0
WETDAYS	1.3	1.0	1.5	0.9	1.4
DRYDAYS	269.9	262.8	270.1	268.2	268.0
FTDAYS	76.4	63.4	68.1	73.3	65.7

TAVE (°F) = annual average temperature; TMAX (°F) = annual average maximum temperature; TMIN (°F) = annual average minimum temperature; PRECIP (inches) = annual average precipitation; GDD = average annual accumulated growing degree days with a base temperature of 50 °F; HOTDAYS (average # of days per year) = average number of days exceeding 90 °F; COLDDAYS (average # of days per year) = average annual number of days below 32 °F; WETDAYS (average # of days per year) = average annual number of days with precipitation exceeding 2 inches in a day; DRYDAYS (average # of days per year) = average annual number of days with precipitation below 0.1 inches in a day; FTDAYS (average # of days per year) = average annual number of freeze-thaw days with maximum temperature exceeding 34.1 °F and minimum below 28.0 °F.

910
 911 Current characteristics of HAFB’s general climate will likely persist through mid-century, although climate
 912 projections indicate average temperatures will tend to increase, along with the number of days with **higher**
 913 **than-normal** temperatures. As a result, the portion of precipitation falling as rain as
 914 opposed to snow may increase, and evapotranspiration may increase resulting in an increase in ecological
 915 pressure related to water availability during the hot summer months.

916 **2.2.2 Landforms**

917 Massachusetts has a diverse natural landscape with rocky shores and sandy beaches, salt marshes, rolling
 918 hills, fertile valleys, and relatively low-elevation mountains, with the highest point being Mount Greylock
 919 at an elevation of 3,491 feet above sea level (FASL). Four regions define Massachusetts’ topography:
 920 coastal lowlands, interior lowlands, dissected uplands, and ancient mountains. HAFB and all of its
 921 geographically separated units lie within the coastal lowlands region.

922 The coastal lowlands are located on the state’s eastern side and extend from the Atlantic Ocean inland. The
 923 most distinct features of the coastal lowlands are the two basin-shaped depressions of less than 200 FASL;
 924 the Boston and Narragansett Basins. Another distinct region within the coastal lowlands is Cape Cod and
 925 nearby islands.

926 **Hanscom Air Force Base**

927 Gentle, low-lying, easterly slopes characterize the topography of HAFB. The average elevation of this site
 928 is approximately 125 FASL. There are several low hills in or adjacent to HAFB, including Reservoir Hill
 929 (225 FASL), Katahdin Hill (300 FASL), Fiske Hill (300 FASL), Pine Hill (231 FASL), and Hartwell Hill
 930 (200 FASL).

931 **Sagamore Hill Solar Weather Observatory Annex**

932 The highest point on Sagamore Hill is 54 FASL. The topography within this area is hilly.

933 **Fourth Cliff Recreation Annex**

934 The site is located on a drumlin bounded by the Atlantic Ocean on one side, North River at the tip of the
935 peninsula, and the South River along the other side (Onderko 2019). The area is relatively flat, with the
936 topography ranging from sea level to tens of FASL, except the western cliff, which covers the western coast
937 of this property and attains a maximum of about 19 FASL.

938 *2.2.3 Geology and Soils*

939 In Massachusetts, most of the surficial geological material was deposited by the retreat of the two most
940 recent ice sheets that covered much of the North American continent (Stone et al. 2018). The thickness of
941 these deposits, which include both glacial and post-glacial materials, varies across the state from a few feet
942 to more than 500 feet, and in some ~~areas~~areas, bedrock is exposed at the land surface. Typically, the depth
943 ~~to~~of bedrock is about 60 feet.

944 **Hanscom Air Force Base**

945 The bedrock underlying HAFB is composed primarily of granite gneiss and schists (Church and Lyford
946 2000). Bedrock surfaces in the HAFB area range from a few feet to a hundred feet below the land surface.
947 Recently modified soils, such as urban land or udorthents formed from earthmoving activities, overlay a
948 large portion of the bedrock at HAFB, although some portions of HAFB retain their original soils. Most of
949 these areas contain sandy loams or loamy sands (e.g., soils of the Scituate, Hinckley, Windsor, Canton,
950 Paxton, Deerfield, and Montauk series) that drain moderately to excessively well. Other soils include
951 Swansea and Freetown muck, which are associated with wetlands and known for their poor drainage
952 qualities.

953 **Fourth Cliff Recreation Annex**

954 Fourth Cliff is underlain by bedrock composed of sedimentary material that formed in a basin. On top of
955 the bedrock, cobbles and boulders are prevalent and, above this layer, the gravel content increases (Onderko
956 2019). From surface level to a depth of 32 inches, the soil consists of Woodbridge fine sandy loam on 8–
957 15 percent slopes and includes stony material. Most of the ~~soil~~soils at this site at lower elevations ~~is~~are
958 subject to effects of frequent flooding during at least half of the year, and soils on unprotected slopes ~~is~~are
959 susceptible to significant erosion, especially during storm events.

960 **Sagamore Hill Solar Weather Observatory Annex**

961 Granite bedrock underlies the surficial materials at Sagamore Hill. Overlying the bedrock are primarily
962 sandy loams with slow rates of infiltration. The ~~soil~~soils, however, ~~are~~is not subjected to effects of flooding
963 and ~~their~~the susceptibility to erosion is low.

964 *2.2.4 Hydrology*

965 **Hanscom Air Force Base**

966 The principal river in this area is the Shawsheen River, which is a tributary to the Merrimack River
967 (Executive Office of Environmental Affairs 2007). The Shawsheen River watershed is located in a
968 predominantly suburbanized area with over 50 percent of the land developed. As a result, impervious

969 surfaces cover a significant portion of the watershed, affecting runoff and water quality, especially given
970 the watershed's proximity to Boston.

971 Prior to the base being built, the river's headwaters arose from a small pond that drained northeastward
972 through a large wetland that eventually emptied into the Merrimack River. Due to the construction and
973 expansion of the base in the 1940s, most of the original headwater areas were filled in; however, remnants
974 still can be found in a swampy region east of the houses along Scott Circle (Abell et al. 1998).

975 Because impervious surfaces cover a significant portion of the river's headwaters area, heavy rains can lead
976 to flash floods. The volume of surface runoff fluctuates seasonally with low flow in the winter months and
977 heavy flow in the spring from rain and thawing snowpack. A series of subterranean storm sewers, pipes,
978 and culverts collect and divert most of the surface water around the base property. The surface water
979 eventually reaches the Shawsheen River and Kiln Brook. A National Pollutant Discharge Elimination
980 System permit issued by the U.S. Environmental Protection Agency (USEPA) regulates the surface water
981 runoff.

982 According to a Flood Insurance Rate Map, the Shawsheen River has a floodway area designated (by the
983 Federal Emergency Management Agency) as a Zone AE that slightly encroaches on HAFB. A floodway
984 designated as Zone AE signifies that the channel of a stream and any adjacent floodplains must be kept free
985 of encroachments so that the 100-year flood can be carried without substantial increases to the flood heights.
986 North Lexington Brook has a Special Flood Hazard Area (SFHA) and there is slight flooding on some of
987 HAFB during a 100-year flood.

988 Groundwater moving under the base also contributes flow to the Shawsheen River, especially from the
989 small forested and shrub wetland areas that cover approximately 14.15 acres of the base. As a result, the
990 Shawsheen River is perennial and does not depend entirely on rainfall for maintaining streamflow.

991 **Fourth Cliff Recreation Annex**

992 This area is part of the South Coastal watershed. Within this watershed, there are two sub-watersheds, North
993 and South Rivers. Both of these watersheds share the same outlet to the Atlantic Ocean between Third and
994 4th Cliffs.

995 Runoff flows into the Atlantic Ocean or New Inlet, at the mouth of the North River. On the more developed
996 side of this location, a stormwater collection system discharges surface water to the ocean.

997 The water that surrounds 4th Cliff is shallow, so the shoreline is subject to coastal storm flowage (i.e., land
998 subject to inundation from coastal storms, including inundation caused by a 100-year storm, a storm surge
999 of record, or a storm of record, whichever is greater; Onderko 2019). As a result, this area is designated as
1000 a SFHA for a 100-year flood, and the surrounding coastal area is considered to be at a very high risk for
1001 flooding. A severe coastal storm in 2018 caused extensive damage (Onderko 2019). It ~~eroded away~~eroded
1002 10 feet of the cliff face, the perimeter road collapsed, and underground utilities were severed. Ongoing
1003 erosion is damaging the coastal embankment, parking area, camping area, picnic area, stairway, and
1004 fencing; thus, addressing shoreline erosion from storm damage is necessary.

1005 **Sagamore Hill Solar Weather Observatory Annex**

1006 Sagamore Hill is located in the Ipswich River watershed. Flow from this area runs to Nicholas Brook near
1007 Burlington, Massachusetts, and then 45 miles more to the mouth of the Ipswich River at Plum Island Sound
1008 (Mass.gov 2021).

1009 **2.2.4.1 Climate Impacts to Hydrology**

1010 Design storm hyetographs are a modeled time distribution of projected extreme rainfall events used for
 1011 flow and flood modeling. CEMML (2022a) produced design storms to detail projected changes in extreme
 1012 precipitation events and possible changes in associated hydrological conditions at HAFB.

1013 Because of the close linkages between projected changes in precipitation and resultant streamflow and
 1014 inundation, CEMML (2022a) modeled 24-hour duration 2- and 10-year frequency design storms for the
 1015 main HAFB site that (given similar climate regimes) may be applied to all areas at HAFB (Perica et al.
 1016 2019; Kao et al. 2020; Kunkel et al. 2020a). [Table 2-5](#) shows total 24-hour duration precipitation depths
 1017 for modeled 10-year frequency and modeled two-year frequency design storms for all four scenarios.

1018 The 10-year frequency design storm model under RCP 4.5 generally projects moderate increases in
 1019 precipitation compared to baseline, with larger increases for the 2050 timeframe. Under RCP 8.5, small to
 1020 moderate decreases in precipitation are projected for 10-year frequency storms, with larger decreases
 1021 projected for the 2050 timeframe. The two-year frequency models follow similar patterns as the 10-year
 1022 events, although increases and decreases in precipitation are smaller ([Table 2-5](#)).

1023 Table 2-5. Design storm precipitation amounts, 10-year and two-year, 24-hour events

Event	Variable	Baseline	RCP 4.5		RCP 8.5	
		2000	2030	2050	2030	2050
10-year	Precipitation (inches)	4.41	5.38	5.70	4.08	3.29
	Change from baseline (%)		20	26	-8	-29
Two-year	Precipitation (inches)	2.72	2.92	2.81	2.47	2.48
	Change from baseline (%)		7	3	-9	-9

1024
 1025 Although 2- and 10-year events may not have historically produced as severe flooding as would be expected
 1026 with larger return intervals, these events may become increasingly intense under a changing climate with
 1027 rainfall that exceeds the soil’s infiltration capacity, leading to an increased flash flooding and/or inundation
 1028 risk especially when the ground is frozen. Further analysis of this effect may be useful, particularly for
 1029 larger and/or less frequent extreme events (Shaw et al. 2011, Christensen et al. 2013, Liang et al. 2020).
 1030 However, the overall patterns between these mid-sized and ~~smaller-sized~~ smaller sized more frequent design
 1031 storms are useful to examine as they represent possible precipitation extremes seen at shorter return
 1032 intervals in the near future.

1033 **2.3 Ecosystems and the Biotic Environment**

1034 **2.3.1 Ecosystem Classification**

1035 The National Hierarchical Framework of Ecological Units (also known as Bailey’s Ecoregions) is a nested
 1036 mapping and classification system that examines soils, physiography, and vegetation types to stratify the
 1037 landscape into smaller areas (Cleland et al. 1997). The largest and broadest of these classification levels is
 1038 a domain—a subcontinental area that groups together related climates by precipitation and temperature.
 1039 Within a domain, divisions represent regional climates, also differentiated by precipitation and temperature
 1040 while having definitive vegetational affinities, such as a forest or prairie. Divisions are subdivided into
 1041 provinces based on climate and vegetative communities that are generally outlined by a major soil zone or
 1042 geologic feature. Provinces are further subdivided into sections on the basis of differences in the
 1043 composition of the climax vegetation type. Using this classification system, the installation falls within the
 1044 Humid Temperate Domain, Hot Continental Division, Eastern Broadleaf Forest Oceanic Province, Section

1045 221A Lower New England. HAFB itself is in the Boston Basin subsection, while Sagamore Hill and 4th
1046 Cliff are in the Gulf of Maine Coastal Lowlands subsection of the Lower New England area.

1047 The Hot Continental Division is characterized by hot summers and cold winters and experiences year-round
1048 precipitation. In the warmer sections, the frost-free season (i.e., growing season) is 5-6 months long but, in
1049 the colder sections, the growing season is only 3-5 months long. The dominant vegetation in this Division
1050 is deciduous forest that forms a dense canopy in summer and sheds the leaves in fall. These forests typically
1051 have a suppressed understory composed of small trees and shrubs that can tolerate the shady closed canopy
1052 during summer. In the spring, herbaceous ground cover is abundant until the trees begin to grow leaves and
1053 shade out the understory. The vegetation composition and local geology lead to soil types such as alfisols,
1054 ultisols, and inceptisols, which are rich in humus and moderately leached. Soils in HAFB and its GSUs,
1055 however, are highly modified by development and hydrologic alteration; thus, most of the mapped soils are
1056 udorthents (soils altered by earth-moving activities) and/or urban land (soils mostly covered by impervious
1057 surfaces) (LEC Environmental Consultants, Inc. 1999).

1058 2.3.2 *Vegetation*

1059 2.3.2.1 **Historical Vegetation Cover**

1060 In the early 1600s, when Europeans arrived in what was to become Massachusetts, myriad Native American
1061 tribes inhabited the region (see [Section 7.14—Cultural Resources Protection](#)). There is ample evidence of
1062 Native American presence along water courses in particular, although resource usage would have extended
1063 outward from these sites (HAFB 2019d). The extent to which Native American use of natural resources and
1064 their other activities influenced the original ecosystems is not fully understood, but their collections of mast,
1065 edible plants, and food animals likely affected those ecosystems. Their agricultural methods consisted of a
1066 rotational approach that initiated with slash and burn, followed by crop cultivation, and, once crop yields
1067 declined, eventual field abandonment was followed by the vegetation reverting to forest (National Park
1068 Service 2009). Native Americans also may have used light understory burning as a land-management tool
1069 (Thompson et al. 2013). As a result, Native American activities likely created a landscape matrix of
1070 developed villages, agricultural sites, and varying successional levels of forest.

1071 One of the landscape features that attracted early settlers to the Massachusetts coast was the presence of
1072 marshes that could provide hay for livestock feed (Hall et al. 2002). The early colonists kept detailed records
1073 called lotting surveys, in which they often noted trees and forest composition in relation to their economic
1074 value. As towns were established, individual lots were surveyed and described, with “witness trees” serving
1075 as reference points (Thompson et al. 2013). Data from these surveys indicate that European settlement and
1076 the following population expansion soon diminished the forests through timber harvesting, forest clearing
1077 to establish towns, and agricultural production (Foster et al. 1998, Hall et al. 2002). By the 1830s, there
1078 were forest patches of varying sizes scattered about Massachusetts, with the least amount of forest cover in
1079 the Boston Basin area, where development had already consumed much of the land. Between 1830 and
1080 1885, approximately 50 percent of the land in eastern Massachusetts had been converted to pasture, hay, or
1081 crop fields; the remaining portions were likely too steep or too wet for development. In the late 1800s, as
1082 pasture and hay crops became less important, the forest cover regained ground until about the 1950s, when
1083 it began to decline again with new surges in development (Hall et al. 2002).

1084 In the early 1600s, the lotting and road surveys conducted by colonists indicated that the original Eastern
1085 Broadleaf Forest ecosystem in the Boston Basin region was characterized by hardwoods, including oak-
1086 hickory (*Quercus-Carya* spp.), mixed pine (*Pinus* spp.), American chestnut (*Castanea dentata*), and maple-
1087 beech-birch (*Acer-Fagus-Betula* spp.) interspersed with softwood elements such as eastern hemlock (*Tsuga*
1088 *canadensis*) (Hall et al. 2002). The upland deciduous forests were interspersed with forested swamps of red

1089 maple (*Acer rubrum*) in low-lying areas where groundwater levels were at or near the surface. There were
1090 freshwater emergent marshes at inland sites and salt marshes along the coast. Numerous tree species of the
1091 Eastern Broadleaf forest produce large quantities of nuts that would have supported a rich assemblage of
1092 wildlife, and the forested swamps, shrublands, marshes, and local waterways provided additional
1093 heterogeneity.

1094 Thompson et al. (2013) note that although the tree species present in colonial-era New England were similar
1095 to those present today, their relative abundances and distributions have changed radically since then. The
1096 strongest driver of change was the level of agricultural clearing that took place. Areas with more agriculture
1097 between 1850 and 1997 correlated to greater changes in forest species composition than uncultivated areas.
1098 Tree species that have declined the most since colonization include American beech (*Fagus grandifolia*),
1099 oak, and hemlock, all of which are late-successional species. In contrast, red maple, black cherry (*Prunus*
1100 *serotina*), and aspen (*Populus* spp.), all of which are early-successional species, have undergone dramatic
1101 population increases. Of important consequence to biodiversity and wildlife habitat/food resources has been
1102 the stark decline of the American chestnut. By the early 1900s after the fungal blight, *Endothia parasitica*,
1103 was introduced, mature chestnuts were nearly extirpated, and the species persisted only because young
1104 saplings can survive for several years before they succumb to the blight (Thompson et al. 2013).

1105 During the 1630s and 1650s, the area of what is now Minute Man National Park was converted from forest
1106 to fields; trees were ~~cut~~cut, and wetlands were ditched and drained. By the 1800s, fruit orchards, vegetable
1107 gardens, and dairy farms were common in that area before residential development replaced these forms of
1108 agricultural open space (National Park Service 2009). Just to the north of Minute Man National Park, land
1109 usage in what was to become HAFB was likely similar to that in the Park.

1110 Coastal areas like 4th Cliff are currently (and probably were historically) characterized by a mix of salt
1111 marshes, rocky shorelines, and occasional tidal flats and subtidal seagrass meadows (Bowen et al. 2018).
1112 Historical changes in vegetation along the Massachusetts coastline were influenced predominantly by
1113 development, as coastal landing sites developed into towns and eventually cities. Salt marshes were initially
1114 important as sources of livestock feed but declined in the area as they were drained and filled to increase
1115 developable space (Bowen et al. 2018).

1116 Oak, hemlock, and pine were probably common in areas surrounding coastal sites, but with decreasing
1117 distance to the coast and increasing influences of salt water and tides on soil conditions, the oak-hemlock
1118 transitioned to shrublands and then to coastal wetlands of various types. Coastal shrublands, which typically
1119 grow within the salt spray zone, support small woody species, such as bayberry (*Myrica pensylvanica*) and
1120 eastern red cedar (*Juniperus virginiana*). Freshwater marshes dominated by grasses, sedges, and rushes in
1121 permanently saturated soils gave way to salt marshes supporting salt-tolerant species such as cordgrass
1122 (*Spartina* spp.) and saltgrass (*Distichlis spicata*). There is little vegetation in coastal dune communities, but
1123 species that do grow there, such as American beachgrass (*Ammophila breviligulata*), seaside goldenrod
1124 (*Solidago japonicus*), and beach pea (*Lathyrus littoralis*), are ~~very important~~important for minimizing
1125 effects of erosion. In pre-industrial times, seagrasses covered over 6,000 hectares of Boston Harbor, but a
1126 cascade of events began with the losses of salt marsh ecosystems, which led to reduced water quality in
1127 coastal outlets, which in turn degraded the coastal seagrass beds. Now only about five percent of the
1128 harbor's seagrass beds remain.

1129 2.3.2.2 Current Vegetation Cover

1130 Hanscom Air Force Base and Sagamore Hill Solar Weather Observatory Annex

1131 The land on most parts of HAFB has been highly disturbed by development activities (LEC Environmental
 1132 Consultants, Inc. 1999), and today the majority of HAFB and its GSUs are developed with various
 1133 structures, roads, and parking areas. The primary vegetative cover type on the remaining undeveloped areas
 1134 of the main base is forested upland, which covers 22 percent of the land area. The forest stands are generally
 1135 immature mixed hardwood/coniferous, but there are some pure stands of American beech, a late-
 1136 successional species that indicates a relatively long period free of disturbance. This type of vegetation
 1137 corresponds to the Appalachian Oak/Chestnut Forest Group and/or the Appalachian-Allegheny Northern
 1138 Hardwood - Conifer Forest Group of the National Vegetation Classification (NVC) system of classifying
 1139 vegetation. The Appalachian Oak/Chestnut Forest group includes mostly closed-canopy deciduous (oak)
 1140 forests and mixed (oak-pine) forests with a mixture of dry-site oak and pine species. Canopy dominants
 1141 include white oak (*Quercus alba*), scarlet oak (*Quercus coccinea*), and black oak (*Quercus velutina*)
 1142 (Gawler & Sneddon, 2015). The Appalachian-Allegheny Northern Hardwood – Conifer group is dominated
 1143 by northern hardwoods such as red maple, sugar maple (*Acer saccharum*), yellow birch (*Betula*
 1144 *alleghaniensis*), American beech, American ash (*Fraxinus americana*), and red oak (*Quercus rubra*) mixed
 1145 with eastern hemlock, red spruce (*Picea rubens*), or eastern white pine (*Pinus strobus*). A small area of
 1146 HAFB corresponds to the Pitch Pine Barrens vegetation group and is strongly dominated by pitch pine
 1147 (*Pinus rigida*) and Appalachian oaks, such as white oak, red oak, scarlet oak, and black oak.

1148 Various wetland types, both natural and manmade, make up five percent and remnant grasslands make up
 1149 less than five percent of the main base (LEC Environmental Consultants, Inc. 1999). Wetlands are the Silver
 1150 Maple - Green Ash - Sycamore Floodplain Forest vegetation ~~group~~group, which is dominated by broad-
 1151 leaved deciduous trees, including red maple, silver maple (*Acer saccharinum*), green ash (*Fraxinus*
 1152 *pennsylvanica*), American sycamore (*Platanus occidentalis*), eastern cottonwood (*Populus deltoides*), and
 1153 bur oak (*Quercus macrocarpa*).

1154 Sagamore Hill remains relatively undeveloped and is primarily dominated by forested uplands and forested
 1155 swamps with species that are representative of the region, similar to what is found on the main base. It is
 1156 more rural than the HAFB area, giving it connectivity to a larger area of undeveloped land and vegetation
 1157 that likely supports a greater diversity of wildlife than HAFB. Vegetation is similar to HAFB, with the
 1158 exception of the floodplain forest and pitch pine groups, which do not occur at Sagamore Hill.

1159 Plants that grow in the forest understory at HAFB and Sagamore hill include shrubs and herbs that can
 1160 tolerate low light conditions under the heavy canopy cover, herbaceous species that complete their lifecycle
 1161 before full leaf-out, and species that can capitalize on sunny gaps in the canopy. Shrubs include highbush
 1162 and lowbush blueberry (*Vaccinium corymbosum* and *V. angustifolium*), swamp azalea (*Rhododendron*
 1163 *viscosum*), sheep laurel (*Kalmia angustifolia*), and sapling trees. Herbaceous species such as Canada
 1164 mayflower (*Maianthemum canadense*) flower extensively in early spring, and wintergreen (*Gaultheria*
 1165 *procumbens*), goldenrod (*Solidago* sp.), woodfern (*Dryopteris carthusiana*), cinnamon fern (*Osmundia*
 1166 *cinnamomea*), tree clubmoss (*Lycopodium obscurum*), and partridgeberry (*Mitchella repens*) are also
 1167 common (LEC Environmental Consultants, Inc. 2008b).

1168 Topographically, HAFB and Sagamore Hill are characterized by little variation, but the vegetation that
 1169 occurs in red maple swamp forests and other low-lying areas where groundwater levels are shallow is very
 1170 different from the upland vegetation. Many of the wetlands have been reconfigured by human activities and
 1171 all are in various stages of succession that range from wet meadows to mature, forested red maple swamps
 1172 (LEC Environmental Consultants, Inc. 1999). Because nearly half of the Shawsheen River watershed has

1173 become developed with impervious surfaces, the remaining wetlands and undeveloped areas are crucial to
 1174 flood control and water quality in the watershed. Wetlands and riparian zones at HAFB also provide habitat
 1175 for listed species, such as turtles and amphibians, and wetlands adjacent to open fields or lawns support
 1176 common elderberry (*Sambucus canadensis*), the host plant for eastern longhorn elderberry beetle
 1177 (*Desmocerus palliatus*), a Massachusetts SSC.

1178 **Invasive Vegetation Species**

1179 Nonnative invasive vegetation species are present at HAFB and Sagamore Hill in upland, forested, and
 1180 wetland habitats. ~~Management~~Management of invasive plants is determined by the list of invasive plants
 1181 generated by the Massachusetts Invasive Plant Advisory Group (MIPAG). Further, the Massachusetts
 1182 Prohibited Plant List (MPPL) provided by the Massachusetts Department of Agricultural Resources is also
 1183 referenced, and species on these lists are considered for management if they occur on the base and threaten
 1184 natural ~~resources~~resources. Documented invasive (I) or likely invasive (LI) plants at HAFB include
 1185 ~~c~~Common buckthorn (*Rhamnus cathartica*) (I), purple loosestrife (*Lythrum salicaria*) (I), common reed
 1186 (*Phragmites australis*) (I), spotted knapweed (*Centaurea stoebe*) (LI), Tatarian honeysuckle (*Lonicera*
 1187 *tatarica*) (LI), black swallow-wort (*Cynanchum louiseae*) (I), tree-of-heaven (*Ailanthus altissima*) (I),
 1188 Japanese knotweed (*Polygonum cuspidatum*) (MPPL), and multiflora rose (*Rosa multiflora*) (I) are present
 1189 at HAFB. Black swallow-wort, spotted knapweed, Japanese knotweed, multi-flora rose, purple loosestrife,
 1190 and common reed are present at Sagamore hill. CEMML (2022b) conducted targeted invasive plant surveys
 1191 for black swallow-wort, tree-of-heaven, Japanese knotweed, purple ~~loosestrife~~loosestrife, spotted knapweed,
 1192 and common reed at both HAFB and Sagamore Hill in 2021. They found 9.17 acres were infested with at
 1193 least one species at HAFB and 1.64 acres were infested with at least one species at Sagamore Hill, with
 1194 some species co-~~occurring~~occurring at some infestation sites (CEMML 2022b). These species compete with
 1195 native plants for resources, reducing habitat quality and some are toxic to wildlife, such as black swallow-
 1196 wort that is harmful to the monarch butterfly (*Danaus plexippus*), a candidate species for federal listing.

1197 **Fourth Cliff Recreation Annex**

1198 The Humarock Peninsula just south of Boston Harbor is characterized by a series of four cliffs that were
 1199 originally drumlins deposited by glaciers. Over time, the sea eroded 100- to 200-foot-high cliffs in the
 1200 drumlins (Davin et al. 1993). 4th Cliff is the northern-most of these features. The 4th Cliff site is heavily
 1201 developed with 22 acres of WWII-era structures and summer cottages; there are 20 acres of undeveloped
 1202 land on a lower peninsula to the west and 14 acres of saltmarsh and beach. In 1931, erosion was estimated
 1203 to be occurring at a rate of 3.7–4.9 meters per year. Currently, erosion continues at a fairly rapid rate and
 1204 has washed away a septic tank, flooded a chlorinating chamber, and three buildings on the northern tip of
 1205 the peninsula fell into the bay. ~~Clearly, infrastructure~~Infrastructure and habitat are at extreme risk of loss at
 1206 4th Cliff. Major reconfigurations of the beach and the North and South Rivers have occurred in the past and
 1207 are likely to occur again. In the late 1800's the outflow for both rivers moved to its current location between
 1208 4th and 3rd Cliff after a severe storm eroded through the barrier beach and filled in the previous discharge
 1209 point (LEC Environmental Consultants, Inc. 2008a).

1210 LEC Environmental Consultants, Inc. (2008a) mapped dense shrub communities, salt marsh, patchwork
 1211 dune communities, and a stand of coniferous trees at 4th Cliff. They found that west-facing slopes are
 1212 colonized by shrubs and herbaceous vegetation, including milkweed (*Asclepias* spp.). The bunker at the
 1213 highest point on the site supports a stand of non-native Scotch pine (*Pinus sylvestris*) that provides the most
 1214 significant nesting habitat in the uplands. Shrub-dominated communities contain a diversity of native
 1215 shrubs, such as dewberry (*Rubus* spp.), bayberry (*Myrica pensylvanica*), and poison ivy (*Toxicodendron*
 1216 *radicans*), and annuals, including yarrow (*Achillea millefolium*), various golden-rod species (*Solidago*

1217 spp.), arrow-wood (*Viburnum dentatum*), hawkweed (*Hieracium pretense*), and evening primrose
 1218 (*Oenothera biennis*). These shrub communities are invaded by non-native species as well, including privet
 1219 (*Ligustrum vulgare*), Tartarian honeysuckle, multiflora rose, and bull thistle (*Cirsium vulgare*). The salt
 1220 marsh community is dominated by salt marsh cordgrass (*Spartina alterniflora*), with salt meadow cordgrass
 1221 (*S. patens*) in the interior parts of the community and seashore alkali grass (*Puccinellia maritima*) in the
 1222 community outskirts on higher ground. The ~~sparsely vegetated~~sparsely vegetated coastal dune area is
 1223 important for nesting least tern (*Sterna antillarum* [a Massachusetts SSC]) and piping plover (federally
 1224 threatened). Where plants, such as beachgrass, poison ivy and beach heather (*Hudsonia tomentosa*), do
 1225 occur on the dunes, they tend to serve as sand stabilizers (LEC Environmental Consultants, Inc. 2008a).

1226 2.3.2.3 Future Vegetation Cover

1227 The CEMML (2022a) Climate Assessment used the Habitat Climate Change Vulnerability Index,
 1228 developed in coordination with NatureServe (Comer et al. 2021), to assess how climate change may
 1229 influence vegetation groups on the installation in the future. CEMML experts first determined vegetation
 1230 classifications at HAFB using the NVC standard, a hierarchical classification system. Using NVC allows
 1231 state and federal agencies to standardize vegetation classification and enables easier collaboration and
 1232 information sharing. CEMML summarized general and specific anticipated effects of climate change on
 1233 vegetative groups below. For further information, refer to the CEMML Climate Assessment for HAFB
 1234 (CEMML 2022a). CEMML found that the ecosystems and associated vegetation at HAFB have low to
 1235 moderate vulnerability to change or degradation under the projected changes in climate.

1236 Slight changes in temperature and precipitation can substantially alter the composition, distribution, and
 1237 abundance of species, and the products and services they provide. The extent of these changes at HAFB
 1238 will also depend on changes in precipitation and fire. In spite of projected increases in annual average
 1239 precipitation, an increase in the frequency of drought is possible and could cause changes in vegetation
 1240 cover (Blair et al. 2014). In general, woodland areas are susceptible to climate change. There is a
 1241 temperature below which the equilibrium state of the ecosystem appears constant, but above which the
 1242 equilibrium of this vegetation cover declines steadily. Losses of vegetative cover coupled with increases in
 1243 precipitation intensity and climate-induced reductions in soil aggregate stability will dramatically increase
 1244 potential erosion rates. Rising temperatures under various climate change scenarios will likely enhance soil
 1245 decomposition; this may also reduce plant productivity over large areas.

1246 The Appalachian Oak/Chestnut Forest vegetation group may be sensitive to disturbances such as spongy
 1247 moths and fires (Kretchun et al. 2014), and might be impacted by other changes, including competitive
 1248 species interactions, insects, and pathogens that are increasing due to climate change (Goldblum 2010). The
 1249 Pitch Pine Barrens vegetation group may be harmed by rising temperatures, increasing abundance of insect
 1250 pests, and changes in wildfire frequency (Kretchun et al. 2014). The Silver Maple - Green Ash - Sycamore
 1251 Floodplain Forest vegetation group may be impacted by changing flooding and fire regimes. Species in this
 1252 group may experience delayed or interrupted reproduction and growth due to prolonged flooding or
 1253 increased mortality from fire damage. Potential positive effects include increased quality of germination
 1254 beds due to silt deposition from flooding. The Appalachian-Allegheny Northern Hardwood - Conifer Forest
 1255 group may be impacted by wildfires, reduced ~~hemlock~~hemlock, and spruce seedling recruitment due to
 1256 changed patterns in temperatures and precipitation, limb and bodily damage from extreme storms, and
 1257 attacks from pest species (Chin et al. 2018, Shuman et al. 2019). White pine seedling survival may be
 1258 benefitted in certain areas by a warming climate (Chinn et al 2018).

1259 Future changes in vegetation are likely to influence the products and services supported by natural resources
 1260 at the installation. To help support resilience, natural resource managers can emphasize activities, such as

1261 restoring native species diversity, considering trends in soil moisture, and evaluating the needs of species
 1262 (e.g., pollinators) and habitat characteristics (e.g., natural hydrologic regimes), that will restore or maintain
 1263 essential functions.

1264 Prescribed fire and mechanical treatments may be appropriate for managing HAFB systems. In addition,
 1265 monitoring for invasive plant expansion, effects of disturbance, and outbreaks of insects or disease due to
 1266 climate stress can support management decisions (Comer et al. 2021). The projected climate conditions will
 1267 favor invasive species and insect outbreaks due to less extreme winters and increasing temperatures;
 1268 controlling invasive species and restoring native vegetation could help sustain the hardwood oak-pine forest
 1269 communities. It is important to implement installation-specific natural resource management programs and
 1270 projects to mitigate and anticipate effects of climate stress and insect/disease outbreaks beyond historic
 1271 patterns, to ensure seed and seedling nursery capacity are sufficient to meet anticipated reforestation
 1272 demand, and to support healthy, sustainably managed mature and old-growth forests (The White House
 1273 2022, [Executive Order 14072](#)).

1274 **2.3.2.4 Turf and Landscaped Areas**

1275 The 846 and 157 acres of land occupied by HAFB and its GSUs, respectively, consists of improved, semi-
 1276 improved, and unimproved grounds. Landscaping and grounds maintenance operations of the main base
 1277 and off-base areas maintain a healthy and aesthetically pleasing environment while promoting a
 1278 professional appearance. Because soils of the area are highly susceptible to erosion, landscape plantings of
 1279 grass, shrubs, and trees are used to reduce soil exposure. Although the use of native plants for landscaping
 1280 is encouraged, some non-native, non-invasive plant species may be present at HAFB, primarily in improved
 1281 areas. All plant species used in landscape operations, including seed mixes, are listed by the 66ABG/CEOH
 1282 in the HAFB Landscape and Grounds Maintenance Plan.

1283 **2.3.3 Fish and Wildlife**

1284 **Hanscom Air Force Base**

1285 Habitat on HAFB consists of urban/developed areas, forest, wetlands, and grasslands. These habitats
 1286 generally support a variety of small mammal species and urban-adapted wildlife, including white-tailed
 1287 deer (*Odocoileus virginianus*) and enhanced populations of small predators, such as raccoons (*Procyon*
 1288 *lotor*). CEMML (2022b) remote camera surveys most frequently captured white-tailed deer with fawns,
 1289 eastern grey squirrel (*Sciurus carolinensis*), raccoon, and eastern chipmunk (*Tamias striatus*) at HAFB.
 1290 Fisher (*Martes pennanti*) and flying squirrel (*Glaucomy* sp.) were recorded for the first time at HAFB in
 1291 2022 (CEMML 2022b). Forested areas provide roosting and foraging habitat for several bat species,
 1292 including the little brown bat (*Myotis lucifugus*), which is ~~state-listed~~[state listed](#) as endangered (Schwab
 1293 2018) and under review for federal listing. Avian species include raptors, songbirds, and grassland nesting
 1294 birds, such as the grasshopper sparrow (*Ammodramus savannarum* [state threatened]) and upland sandpiper
 1295 (*Bartramia longicauda* [state endangered]; LEC Environmental Consultants, Inc. 1999, S&S
 1296 Environmental ~~Consultants~~[Consultants](#), LLC 2019). Wetlands support breeding amphibians, including the
 1297 blue-spotted salamander (*Ambystoma laterale*), a Massachusetts SSC (CEMML 2022b). Wetlands may
 1298 provide habitat for aquatic ~~reptiles~~[reptiles](#); ~~however~~[however](#), they are unlikely to support breeding
 1299 populations (Massachusetts Port Authority [Massport] 2019, Partners in Amphibian and Reptile
 1300 Conservation [PARC] 2019). Fish surveys at HAFB have not been extensive and currently there are no
 1301 recreational fishing opportunities on base (LEC Environmental Consultants, Inc. 1999). A full list of species
 1302 present or expected at HAFB is provided in [Table 14-2](#) within [Appendix B](#).

1303 The two following sections are reviews of current literature regarding species confirmed or expected to
 1304 occur at each GSU. It is likely there are additional species present that have not been recorded previously.
 1305 Additional baseline surveys should be conducted at HAFB and the GSUs and, once these surveys have been
 1306 completed, these sections will be updated with the results. Protected species and their protection status are
 1307 further discussed in Section 2.3.4.

1308 **Fourth Cliff Recreation Annex**

1309 The 4th Cliff property provides a variety of habitats, including salt marshes, coastal sand dunes, coastal
 1310 ~~beach~~beaches, barrier beach, tidal estuary, coastal ocean, and upland developed areas (HAFB 2014,
 1311 Jorgenson et al. 2019). These habitats support nesting and migrating shorebirds, seabirds, and urban-
 1312 adapted scavenging mammals that can prey on sensitive wildlife species. [Table 14-3](#) within [Appendix B](#)
 1313 provides a list of species known or expected to occur at 4th Cliff.

1314 Terrestrial mammals present at 4th Cliff, including Virginia opossum (*Didelphis virginiana*), raccoon, and
 1315 striped skunk (*Mephitis mephitis*), are typical of developed areas (HAFB 2014). Harbor seals (*Phoca*
 1316 *vitulina*) have been observed travelling in the New Inlet estuary to rest (LEC Environmental Consultants,
 1317 Inc., 2008a). In 2017, bat surveys confirmed the presence of seven species at 4th Cliff, including the silver-
 1318 haired bat (*Lasionycteris noctivagans*), and the protected little brown bat and tricolored bat (*Perimyotis*
 1319 *subflavus*) (Schwab 2018).

1320 The 4th Cliff site, which provides a variety of coastal habitats for migrating, nesting, and foraging avian
 1321 species, is part of the designated Important Bird Area of North River (Massachusetts Audubon Society
 1322 [Mass Audubon] 2021). Protected avian species observed in the coastal habitats of 4th Cliff include
 1323 common tern (*Sterna hirundo*), least tern (*Sternula antillarum*), piping plover, and red knot (LEC
 1324 Environmental Consultants, Inc., 2008a; HAFB 2014, 2019c Jorgenson et al. 2019). The New Inlet estuary
 1325 provides habitat for several invertebrates that are important shorebird prey, including the blue mussel
 1326 (*Mytilus edulis*), razor clam (*Ensis directus*), and rock crab (*Cancer irroratus*) (LEC Environmental
 1327 Consultants, Inc., 2008a; HAFB 2014).

1328 A new fish survey is needed because the last extensive fish surveys were conducted in 1965. Species
 1329 detected during those surveys included recreational targets, such as Atlantic cod (*Gadus morhua*), Atlantic
 1330 herring (*Clupea harengus*), and windowpane flounder (*Scophthalmus aquosus*) (Fiske et al. 1966, in LEC
 1331 Environmental Consultants, Inc., 2008a). See [Table 14-3](#) in [Appendix B](#) for the full list of species at Fourth
 1332 Cliff.

1333 **Sagamore Hill Solar Weather Observatory Annex**

1334 At Sagamore Hill, there are forest and wetland habitats similar to those at HAFB, but Sagamore Hill is
 1335 located in a more rural area, where there is greater habitat connectivity to a larger, less-developed landscape.
 1336 Small mammals, white-tailed deer, and several protected bats are present on Sagamore Hill, including the
 1337 northern long-eared bat, and the little brown and tricolored bats. LEC Environmental Consultants, Inc.,
 1338 (2008b) conducted avian surveys on Sagamore Hill and detected several songbird species, ruffed grouse
 1339 (*Bonasa umbellus*), and American woodcock (*Scolopax minor*). Wetlands and adjacent forest at Sagamore
 1340 Hill may provide suitable habitat for reptiles observed in the surrounding areas, including several snake and
 1341 turtle species. Three species of salamander are also potentially present at Sagamore Hill, including the state
 1342 threatened blue-spotted salamander (LEC Environmental Consultants, Inc., 2008b; Town of Hamilton
 1343 2009). A full list of species confirmed or expected at Sagamore Hill is provided in [Table 14-4](#) in [Appendix](#)
 1344 [B](#).

1345 2.3.3.1 Climate Impacts on Fish and Wildlife Species

1346 The impacts of the projected changes in climate on fish and wildlife at HAFB will depend on the flora and
 1347 fauna's ability to adapt to extreme temperature fluctuations, possible changes in seasonal timing, and
 1348 periods of water deficiency. Projected increases in temperature and slight increases in precipitation may
 1349 pose numerous indirect threats. For example, migrating birds may be indirectly vulnerable to rising
 1350 temperatures because they time their migration to coincide with the springtime emergence of insects. If
 1351 rising temperatures prompt insects to emerge earlier, birds migrating to or through the installation could
 1352 miss a major feeding opportunity, potentially reducing their populations (Both et al. 2010). Similarly, bats
 1353 also time their emergence and arrival with the emergence of vegetation and peak abundances of invertebrate
 1354 prey, and shifts in climate could decouple this timing (Both et al. 2010). Additionally, earlier onset of spring
 1355 may also disrupt the timing of pollinators, which could lead to decreases in both pollinator and plant
 1356 populations. The changing climate could also impact fish and wildlife populations indirectly by altering
 1357 vegetation communities, especially for specialist species that depend on native plants (Gonzalez et al. 2010,
 1358 Hufnagel and Garamvölgyi 2014). Storm surges and sea level rise may displace species from their habitat
 1359 by vegetative alteration or complete inundation and habitat loss.

1360 Climate change may also open niches for non-native invasive species on HAFB, as newly arriving invasive
 1361 species often outcompete native species already experiencing reduced fitness due to shifting environmental
 1362 conditions (Hellmann et al. 2008a). Rising temperatures and changes in precipitation could also increase
 1363 the potential for outbreaks of infectious diseases such as white-nose syndrome and West Nile virus, which
 1364 have caused dramatic impacts to bat and avian communities respectively (Pounds et al. 2006, Petersen and
 1365 Hayes 2008, Süß et al. 2008, Rohr and Raffel 2010, Baylis 2017).

1366 2.3.4 Threatened and Endangered Species and Species of Concern

1367 The USESA defines endangered species as those “. . . at risk of extinction within the foreseeable future
 1368 throughout all, or a significant portion of their range,” and threatened species are those “. . . likely to become
 1369 endangered within the foreseeable future throughout all, or a significant portion of their range.” The USESA
 1370 prohibits “take” of listed species, take being defined as to “. . . harass, harm, pursue, shoot, wound, kill,
 1371 trap, capture, or collect, or to attempt to engage in any such conduct” (16 U.S.C 1531–1544, as amended).

1372 The Massachusetts Endangered Species Act (MESA; Massachusetts General Law [M.G.L], Title XIX,
 1373 c.131A, *Massachusetts Endangered Species Act* of 1990, as amended) uses the same definitions for T&E
 1374 species as the USESA. The MESA defines SSC as any species (or subspecies) that has undergone a decline
 1375 that could threaten the species if the decline continues unabated. The MESA prohibits any “take” of state-
 1376 listed species, defined for wildlife as “. . . harass, harm, pursue, hunt, shoot, hound, kill, trap, capture,
 1377 collect, or process, disrupt nesting, breeding, feeding or migratory activity, or attempt to engage in any such
 1378 conduct, or to assist such conduct,” or “disruption of nesting, breeding, feeding, or migratory activities
 1379 resulting from, but not limited to, the modification, degradation, or destruction of habitat.” ~~and~~ Take is
 1380 defined for plants as “. . . collect, pick, kill, transplant, cut, or process, or attempt to engage or to assist in
 1381 any such conduct.” The MESA further regulates designated “Priority Habitat” and “Estimated Habitat” by
 1382 requiring that projects conducted in either designated habitat type undergo a regulatory review by the
 1383 Massachusetts Natural Heritage and Endangered Species Program (NHESP). “Priority Habitat” is defined
 1384 as the known geographical extent of habitat for any state-listed plant or animal species (M.G.L, Title XIX,
 1385 c.131A, 1990, as amended), and “Estimated Habitat” is defined as the geographical extent of habitat for
 1386 wetland wildlife, regulated under the Massachusetts Wetlands Protection Act (M.G.L., Title XIX, c.131,
 1387 Section 40).

1388 The following sections on state and ~~federally-listed~~federally listed T&E species and SSC are based on
 1389 surveys that confirmed presence, as well as literature reviews and desktop surveys that suggest potential
 1390 presence, at HAFB and its GSUs. Desktop surveys were conducted by reviewing online mapping programs
 1391 that show distributions of listed species that overlap the boundaries of each GSU, provided by the USFWS
 1392 (2021b), the National Oceanic and Atmospheric Administration ([NOAA] 2021), and NHESP
 1393 (Massachusetts Bureau of Geographic Information [MassGIS] 2021). Extensive surveys of all taxa are
 1394 needed to confirm the presence of listed species; the results will be incorporated into this section as surveys
 1395 are completed.

1396 **2.3.4.1 Plants**

1397 There are no known plant species listed as threatened or endangered, or plant SSC at HAFB, but inventory
 1398 surveys for all species have not been completed. There are 259 state-listed plant species in Massachusetts,
 1399 three of which (sandplain gerardia [*Agalinus acuta*], northeastern bulrush [*Scirpus ancistrochaetus*], and
 1400 American chaffseed [*Schwalbea americana*]) are federally endangered and one of which (small-whorled
 1401 pogonia) is federally threatened ([Table 14-8 in Appendix B](#)) (Mass.gov 2021). Of these, small-whorled
 1402 pogonia could occur on Sagamore Hill, and several of the state-listed species could occur at HAFB.

1403 CEMML (2022b) developed a GIS suitability model of small-whorled pogonia habitat at Sagamore Hill,
 1404 using scientific literature on the species' habitat requirements and publicly available data from federal
 1405 agencies and other data sources. This model resulted in the highest potential for small-whorled pogonia in
 1406 the southeastern portion of Sagamore Hill; this area was confirmed as suitable for this species during a site
 1407 visit in 2021 (CEMML 2022b).

1408 M.N. Gilbert was subcontracted by CEMML as a USFWS Recognized Qualified small-whorled pogonia
 1409 surveyor [in the state of Pennsylvania](#) to [conduct surveys on](#) Sagamore Hill for small-whorled pogonia in
 1410 June 2021. No small-whorled pogonia were ~~identified, however~~found, but tree species that support the
 1411 ectomycorrhizal fungi associated with small-whorled pogonia were present at Sagamore Hill. M.N. Gilbert
 1412 therefore recommended follow up surveys in mid- to late-May ~~to determine the presence of small-whorled~~
 1413 ~~pogonia~~. Such follow-up surveys in 2022 did not detect any small-whorled pogonia. [USFWS small-whorled](#)
 1414 [pogonia survey guidelines recommend a survey period between mid-June and October in Massachusetts,](#)
 1415 [but the timing of the survey was appropriate for the site, as determined by the recognized surveyor.](#) Surveys
 1416 [should continue ~~in~~ on this site regularly.](#)

1417 **2.3.4.2 Invertebrates**

1418 There are 99 federally protected invertebrate species found in Massachusetts, including sponges, flatworms,
 1419 segmented worms, snails, mussels, crustaceans, and insects (Mass.gov 2021). Baseline invertebrate surveys
 1420 are needed to determine which, if any, of these species occur at HAFB, Sagamore Hill, or 4th Cliff. To
 1421 maintain compliance with the USESA, 16 USC §§ 1531–1544, invertebrate surveys are needed to gather
 1422 baseline data about which protected species occur at HAFB and its GSUs. The only invertebrate species
 1423 with federal status likely to be found on the main base, Sagamore Hill, and/or 4th Cliff are the intricate
 1424 fairy shrimp (*Eubbranchipus intricatus*), monarch butterfly (*Danaus plexippus*), and yellow-banded bumble
 1425 bee (*Bombus terricola*).

1426 The intricate fairy shrimp is an aquatic crustacean; more specifically, it is a vernal pool obligate. Although
 1427 the intricate fairy shrimp occurs throughout Canada, in the U.S., it is found only in Massachusetts and
 1428 Montana (NHESP 2015f). Fairy shrimp of unknown species were detected in suitable vernal pools at HAFB
 1429 (LEC Environmental Consultants, Inc. 1999), but intricate fairy shrimp have not been confirmed. Intricate
 1430 fairy shrimp eggs have dark coverings that protect the embryo from freezing, heat, and seasonal drying out

1431 of vernal pools. Eggs hatch and the young undergo several rapid molts until they attain adult stage. The
 1432 adults filter feed on bacteria, phytoplankton, and detritus during the vernal pools' wet period. The adults
 1433 can produce several clutches of eggs during their lifetime before dying off when water temperatures exceed
 1434 50 °F (NHESP 2015f). Vernal pools are wet during winter and spring, but they dry out during the
 1435 spring/summer months; thus, they cannot support fish and are typically used by amphibians for breeding
 1436 (NHESP 2015f). Threats to intricate fairy shrimp include loss of vernal pool habitat to development,
 1437 changes in hydrology, pollutants, and intentional fish stocking (NHESP 2015f).

1438 The monarch butterfly is currently a candidate for listing under the USESA because the species' populations
 1439 declined substantially over the last 30 years (Brower et al. 2012). Major factors contributing to the species'
 1440 decline include a dearth of nectar-bearing plants, particularly during southward migration (Inamine et al.
 1441 2016); high rates of mortality during migration (Badgett and Davis 2015); habitat loss/fragmentation
 1442 (Pleasants and Oberhauser 2013); and exposure to chemicals (Pecenka and Lundgren 2015). Climate
 1443 change is likely to exacerbate the monarch's ~~status decline~~ by increasing volatility in local weather patterns
 1444 at overwintering sites (Barve et al. 2012) and reducing important breeding habitat (Batalden et al. 2007).

1445 The yellow-banded bumble bee, also a candidate for listing, faces many of the same threats as the monarch
 1446 butterfly. Habitat loss/fragmentation, diminishing floral resources, and exposure to chemicals have led to
 1447 this species' decline (Goulson et al. 2015, USFWS 2018b). The arrival of an invasive European bee parasite,
 1448 *Nosema bombi*, also has contributed significantly to the yellow-banded bumble bee's decline (Cameron et
 1449 al. 2016). The species' ongoing decline has been compounded further by inbreeding as a result of low
 1450 population sizes (Kent et al. 2018).

1451 Population declines among invertebrate species can be attributed to multiple causes (Eggleton 2020).
 1452 Habitat loss has played a large role in reducing overall invertebrate diversity. Since the early 1800s,
 1453 intensification of agricultural practices and a nearly 500 percent increase in agricultural land use (Meyer
 1454 and Turner 1992), particularly the concomitant drainage of wetlands (Batzer and Wissinger 1996), led to a
 1455 drastic reduction in high-quality invertebrate habitats. More recently, use of pesticides and other chemicals
 1456 (Beketov et al. 2013) has caused direct invertebrate mortality and bioaccumulation of toxins in the food
 1457 web. Urbanization also contributes to habitat loss, fragmentation (Tscharntke et al. 2002), and
 1458 homogenization (Guenat et al. 2019, Docile et al. 2016), which, in turn, leads to diminished invertebrate
 1459 diversity. Urbanization also leads to pollution that reduces insect viability (Whittaker 2001), and artificial
 1460 light in urban areas ~~attract~~ attracts insects, altering their mating and migration behaviors (Hölker et al. 2010).
 1461 Climate change is likely to further compound problems for state-listed species by shifting the ranges of
 1462 natural ecosystems (Hickling et al. 2005, Habel et al. 2016) and expanding the ranges of existing invasive
 1463 species (Hellman et al. 2008).

1464 **2.3.4.3 Vertebrates**

1465 **Hanscom Air Force Base**

1466 Twelve species listed as endangered, threatened, or SSC under the USESA and/or the MESA have either
 1467 been confirmed or have the potential to occur at HAFB ([Table 2-6](#)). The following sections include a
 1468 summary for each species, grouped by taxonomic order. The summaries indicate whether the species has
 1469 been confirmed at HAFB, ecological information important for management considerations, and the threats
 1470 facing their populations. There are no state-designated "Priority Habitats" or "Estimated Habitats" at HAFB
 1471 (MassGIS 2021).

Table 2-6. Threatened and endangered vertebrate species and vertebrate species of special concern confirmed or potentially occurring at Hanscom Air Force Base.

Common Name	Scientific Name	Listing Category ¹	Status on Base
<i>Mammals</i>			
Little brown bat	<i>Myotis lucifugus</i>	SE & UR	Confirmed
Northern long-eared bat	<i>Myotis septentrionalis</i>	FT & FE**	Potential
<i>Birds</i>			
Eastern meadowlark	<i>Sturnella magna</i>	SSC	Potential
Grasshopper sparrow	<i>Ammodramus savannarum</i>	ST	Confirmed
Sedge wren	<i>Cistothorus platensis</i>	SE	Potential
Upland sandpiper	<i>Bartramia longicauda</i>	SE	Potential
<i>Reptiles</i>			
Blanding’s turtle	<i>Emydoidea blandingii</i>	ST & UR	Potential
Eastern box turtle	<i>Terrapene carolina</i>	SSC	Potential
Wood turtle	<i>Glyptemys insculpta</i>	SSC & UR	Potential
<i>Amphibians</i>			
Blue-spotted salamander	<i>Ambystoma laterale</i>	SSC	Confirmed
<i>Fish</i>			
Bridle shiners	<i>Notropis bifrenatus</i>	SSC	Potential

¹FE= Federally Endangered, FT= Federally Threatened, FC= Federal Candidate, SE= State Endangered, ST= State Threatened, SSC= Massachusetts State Species of Special Concern, UR= Under review for federal listing, **= Effective March 31 2023.

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1473
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1476 **Bats**

1477 The northern long-eared bat was listed as threatened under the USESA in April 2015 and reclassified to
1478 endangered under the USESA in November 2022, effective 31 March ~~31~~ 2023. In 2017, Tetra Tech, Inc.,
1479 and the University of Montana conducted acoustic bat surveys at HAFB, Sagamore Hill, and 4th Cliff
1480 (Schwab 2018). The acoustic recordings were analyzed with Kaleidoscope Pro to auto-classify echolocation
1481 signatures to the species level, and then the identifications were confirmed manually except for northern
1482 long-eared bat, which was not confirmed manually at HAFB. Schwab (2018) noted that the echolocation
1483 signature of northern long-eared bat overlaps that of other myotis species, and their high-frequency
1484 echolocations in forested environments are quickly attenuated; thus, echolocations that were auto-classified
1485 but not manually confirmed as northern long-eared bat cannot be interpreted definitively as an absence of
1486 northern long-eared bat. Although the auto-classified detection was insufficient to confirm northern long-
1487 eared bat absence/presence, future surveys should continue until northern long-eared bat presence or
1488 absence can be confirmed at HAFB because there is suitable habitat at HAFB. The nearest known northern
1489 long-eared bat hibernaculum is approximately 10 miles away (NHESP 2021a).

1490 Moreover, the state endangered little brown bat, which has similar habitat requirements, was confirmed as
1491 present by the surveys (Schwab 2018). Little brown bats were detected at the edges of forest patches running
1492 north-south on the eastern side of the installation (Schwab 2018). The little brown bat is also under review
1493 for federal listing.

1494 During summer, northern long-eared bat and little brown bat roost in tree cavities and snags and forage
 1495 over wetland sites, small streams, and forests. Little brown ~~bat~~bats also will roost in buildings. In winter,
 1496 ~~species these bats~~ enter hibernacula in humid caves, mines, wells, and aqueducts. White-nose syndrome is
 1497 the primary cause of population decline in both species. White-nose syndrome is an invasive fungal disease
 1498 that spreads through hibernacula and causes individuals to rouse frequently and consume fat reserves (Frick
 1499 et al. 2010; Kunz and Reichard 2010; USFWS 2013a; NHESP 2019b, 2019c). Additional threats include
 1500 habitat fragmentation, loss of habitat, collisions with wind turbines, and climate change (Arnett et al. 2008b;
 1501 Kunz et al. 2007; Langwig et al. 2015b). Little brown bat was once the most abundant bat species in the
 1502 northern states, but northeastern populations have declined by 90–100 percent as a result of white-nose
 1503 syndrome infection acquired in their hibernacula (NHESP 2019b, NatureServe 2022g).

1504 **Grassland Birds**

1505 The state-threatened grasshopper sparrow (*Ammodramus savannarum*) has been confirmed on grasslands
 1506 in the northern section of HAFB, and nesting on Hanscom Field Airport (HAFB 2017b). The state-
 1507 endangered upland sandpiper (*Bartramia longicauda*) and eastern meadowlark (*Sturnella magna* [a species
 1508 of special concern]) ~~and~~ have also been confirmed on ~~the adjacent~~ Hanscom Field Airport; ~~these both of~~
 1509 these species may use isolated grassland patches on HAFB, but they have not been confirmed there
 1510 (Massport 2019). Many of these birds are long distance ~~These species~~ migrants, traveling from Mexico,
 1511 and Central America, and/or South America to breed in ~~many the~~ northeastern states U.S., including
 1512 Massachusetts, where they are present from mid-April to mid-September. All three species require
 1513 grassland habitat comprising a mosaic of taller bunch grasses for nesting, with small patches of open short
 1514 vegetation/bare ground for foraging. The latter is particularly important for grasshopper sparrows as they
 1515 run along the ground to escape from predators and forage for invertebrates (NHESP 2015e). The primary
 1516 cause of declines in these species is loss of grassland habitat resulting from the succession of abandoned
 1517 agricultural lands, urban development, and changing agricultural practices (NHESP 2015e, 2015k, 2020).

1518 Sedge wrens (*Cistothorus platensis*) breed in Massachusetts from late May to August in wet meadows
 1519 found along the drier edges of wetlands. There is suitable wet meadow habitat for sedge wrens at HAFB,
 1520 but the species has not been confirmed there. The species was recorded most recently in 1993 in the town
 1521 of Lincoln (which partially overlaps part of HAFB) (NHESP 2021b). As with other grassland species, loss
 1522 of habitat to agriculture and urban development is negatively impacting sedge wren populations (NHESP
 1523 2015i).

1524 **Reptiles**

1525 Protected turtle species may be present on HAFB or the associated GSUs. The wood turtle (*Glyptemys*
 1526 *insculpta*) is a Massachusetts SSC and under review for federal listing. It was reported at HAFB in PARC
 1527 (2019), and to the west of HAFB; ~~however, this is likely an erroneous identification as this species was not~~
 1528 ~~reported in the MassWildlife natural heritage data release~~ (MassWildlife 2021). However, it was not, or
 1529 found in during CEMML (2022b) eDNA surveys for herpetofauna at HAFB. Additionally, although they
 1530 were not detected during CEMML's (2022b) eDNA sampling, Blanding's turtles were confirmed to the
 1531 west of Hanscom Field (Massport 2019). There are also unconfirmed reports of Blanding's turtle in the
 1532 Shawsheen River adjacent to HAFB. Finally, the eastern box turtle may occur within uplands of HAFB. As
 1533 a terrestrial species, eastern box turtles are not detectable in aquatic eDNA sampling surveys. Eastern box
 1534 turtles were most recently confirmed within the town of Bedford in 2004 (which overlaps portions of
 1535 NAFB) (NHESP 2021b).

1536 The base's undeveloped wetlands and upland forests ~~provide marginal~~provide marginal habitat for wood
 1537 turtles, Blanding's turtle (*Emydoidea blandingii*), and eastern box turtle (*Terrapene carolina*); these species

1538 are unlikely to breed on HAFB, but may occasionally cross through the property while traveling to higher
 1539 quality habitat patches adjacent to the installation. ~~CEMML (2022b) eDNA sampling did not detect wood~~
 1540 ~~turtles or Blanding's turtles. As a terrestrial species, the eastern box turtle would not be detectable from~~
 1541 ~~aquatic eDNA samples. Blanding's turtle was confirmed west of Hanscom Field (Massport 2019) and there~~
 1542 ~~are unconfirmed reports of Blanding's turtle in the Shawsheen River area adjacent to HAFB. Eastern box~~
 1543 ~~turtles were last confirmed within the town of Bedford in 2004 (which overlaps portions of HAFB) (NHESP~~
 1544 ~~2021b).~~

1545 Blanding's and wood turtles overwinter from November–March in the organic substrate of marshes/
 1546 ponds, or vernal pools (for ~~Blandings~~Blanding's) and sand/ or gravel stream beds (for wood turtles);
 1547 respectively. Eastern box turtle is a terrestrial species that overwinters under the soil surface of upland
 1548 forests. In summer, all three turtle species forage and breed in upland habitat, where they lay their eggs in
 1549 soft, sandy to loamy soil. Females may travel relatively long distances for nesting (up to 1 mile), exposing
 1550 them to predators and mortality when crossing roads. The populations of all three turtle species are
 1551 particularly sensitive to small increases in adult mortality, as females do not reach sexual maturity until
 1552 they are 13–20 years old (NHESP 2015a, 2015c). The primary threats to their populations are loss of habitat,
 1553 habitat fragmentation, poaching for the pet trade, road mortality, the availability of food sources in
 1554 developed areas that artificially increases predator abundance, and the release of domestic turtles carrying
 1555 exotic pathogens (NHESP 2015a, 2015c, 2015l; PARC 2019).

1556 ***Blue-Spotted Salamander***

1557 The blue-spotted salamander (*Ambystoma laterale*) has been detected at HAFB and suitable habitat is
 1558 present ~~throughout the~~in some of the wetlands present (HAFB 2017b, CEMML 2022b). Blue-spotted
 1559 salamander eDNA was detected in a wetland between Liberty Lane and Heritage Road, and follow up
 1560 SWCA Environmental Consultants (2022) surveys identified blue-spotted salamander egg masses near the
 1561 intersection of Airport Road and Wright Street, confirming that breeding takes place on HAFB. Blue-
 1562 spotted salamander winter in rodent tunnels below the frost line and migrate to breeding wetlands between
 1563 late February and early April (NHESP 2016a). Blue-spotted salamander habitat consists of deciduous and
 1564 mixed deciduous/coniferous forests with sandy to loamy soils and suitable breeding wetlands, swamps, and
 1565 vernal pools (NHESP 2016a). Spring migration from underground winter habitat to breeding wetlands
 1566 occurs at night after rainfall events when temperatures exceed 40 °F; during this migration they are
 1567 particularly vulnerable to road mortality as individuals move ~~in~~en masse to breeding wetlands at
 1568 approximately the same time (NHESP 2016a). Blue-spotted ~~salamanders~~salamanders are vulnerable to road
 1569 mortality throughout the breeding season and during the fall migration, but individuals are more dispersed
 1570 at these times than they are during the spring migration. Primary threats to blue-spotted salamander include
 1571 habitat loss, habitat degradation, road mortality and infectious diseases, including ranavirus and
 1572 Chytridiomycosis (a fungal disease caused by *Batrachochytrium dendrobatidis* and *B. salamandrivorans*,
 1573 with the former infecting amphibians generally and the latter infecting salamanders specifically) (NHESP
 1574 2016a).

1575 Blue-spotted salamanders belong to a complex of mole salamanders that includes genetically pure forms
 1576 and unisexual hybrids resulting from ~~cross breeding~~crossbreeding with Jefferson salamanders (*Ambystoma*
 1577 *jeffersonianum*). Blue-spotted salamander populations typically consist of both genetically pure and
 1578 unisexual forms, which are able to interbreed, which results in further genetic dilution of true blue-spotted
 1579 salamander. Therefore, exclusively pure-form populations are considered high-priority targets for
 1580 conservation. Size and coloration differences ~~allow observers to~~differentiate the forms in the field:
 1581 unisexual individuals are larger than pure individuals, and unisexual individuals are gray-brown, whereas
 1582 the pure forms are jet-black (NHESP 2016a). Only egg masses were observed on HAFB in 2022, therefore

1583 the genetic form was not determined. However, populations at HAFB are likely to be part of the widely
1584 distributed unisexual form.

1585 ***Bridle Shiner***

1586 The bridle shiner (*Notropis bifrenatus*) is a small minnow that inhabits slow-moving, clear-water streams,
1587 rivers, and lakes with aquatic vegetation and open areas for schooling (NHESP 2015b). They are visual
1588 predators and are thus susceptible to changes in turbidity, exotic plants blocking out open areas, and
1589 increased flow (NHESP 2015b). The species has not been confirmed at HAFB; however, there is suitable
1590 stream habitat in the Shawsheen River, and in 2013 the species was detected in the town of Bedford (which
1591 overlaps the northern portion of HAFB) (NHESP 2021b).

1592 **Sagamore Hill Solar Weather Observatory Annex**

1593 Six federally- and state-listed species are confirmed or have the potential to occur at Sagamore Hill (

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Table 2-7. Threatened and endangered species and species of special concern confirmed or potentially occurring at Sagamore Hill.

1594). For species already described above in the HAFB section, only their presence and suitable habitat at
1595 Sagamore Hill will be discussed in this section. There are no state-designated “Priority Habitats” or
1596 “Estimated Habitats” at Sagamore Hill (MassGIS 2021).

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Table 2-7. Threatened and endangered species and species of special concern confirmed or potentially occurring at Sagamore Hill.

Species	Scientific Name	Listing Category ¹	Status on Unit
<i>Mammals</i>			
Northern long-eared bat	<i>Myotis septentrionalis</i>	FT & FE**	Confirmed
Little brown bat	<i>Myotis lucifugus</i>	SE & UR	Confirmed
Tricolored bat	<i>Perimyotis subflavus</i>	SE & PE	Confirmed
<i>Birds</i>			
Golden-winged warbler	<i>Vermivora chrysoptera</i>	SE & UR	Potential
<i>Reptiles</i>			
Blanding’s turtle	<i>Emydoidea blandingii</i>	ST & UR	Potential
<i>Amphibians</i>			
Blue-spotted salamander	<i>Ambystoma laterale</i>	SSC	Potential

1598 ¹ FE= Federally Endangered, FT= Federally Threatened, PE= Proposed Endangered, SE= State Endangered, ST= State
 1599 Threatened, SSC= Massachusetts Species of Special Concern, UR= Under review for federal listing, **=
 1600 Effective March 31 2023.
 1601

1602 **Bats**

1603 In 2017, the northern long-eared bat, little brown bat, and tricolored bat (*Perimyotis subflavus*) were
 1604 confirmed at Sagamore Hill (Schwab 2018) with acoustic monitoring stations placed in open areas adjacent
 1605 to forested habitat throughout the center of Sagamore Hill (Schwab 2018). The nearest known northern
 1606 long-eared bat hibernaculum is located approximately 14.5 miles to the southwest (NHESP 2021a).

1607 The tricolored bat is state endangered and is proposed federally endangered. Its life history is similar to that
 1608 of northern long-eared bat and little brown bat. In summer, they roost in the canopy of forested areas,
 1609 particularly among dead leaves on mature deciduous trees. They forage at the tree-top level, in open fields,
 1610 over water courses, and along forest-field edges. In winter, they hibernate in high-humidity limestone caves
 1611 and abandoned mines. There are known hibernacula in Berkshire, Franklin, and Hampden counties of
 1612 western Massachusetts, and these bats are known to travel up to 85 miles between summer roosting areas
 1613 and winter hibernacula, but in summer they travel approximately 5 miles to forage. Once the third most
 1614 abundant bat species in Massachusetts, populations of tricolored bats declined following the start of
 1615 pesticide use in the mid-1900s, but their populations were beginning to recover until outbreaks of white-
 1616 nose syndrome began in 2007–2008; losses to white-nose syndrome in hibernacula have exceeded 90
 1617 percent (Kurta et al. 2007; Langwig et al. 2015a, 2016; NHESP 2015j). Additional causes of decline are
 1618 collisions with wind turbines, habitat loss, pesticide use, and climate change (Arnett et al. 2008a; Center
 1619 for Biological Diversity and Defenders of Wildlife 2016; Kunz et al. 2007; Langwig et al. 2015a; USFWS
 1620 2015c, 2018a)

1621 **Golden-Winged Warbler**

1622 The presence of golden-winged warbler (*Vermivora chrysoptera*) has not been confirmed at Sagamore Hill
 1623 and suitable habitat at that site is limited; however, the species is observed infrequently in the town of
 1624 Hamilton, which includes Sagamore Hill (Town of Hamilton 2009, NHESP 2021b). The golden-winged
 1625 warbler is a migratory songbird that winters in Mexico and Central and South America, and breeds

1626 throughout the eastern U.S., including Massachusetts. In the early part of the 20th century, golden-winged
 1627 warbler numbers increased following the abandonment of agricultural land that become second-growth
 1628 forest habitat, which the species uses for nesting (NHESP 2015d). Following further vegetation succession,
 1629 this habitat favored the blue-winged warbler (*Vermivora cyanoptera*), a species that has been outcompeting
 1630 and hybridizing with golden-winged warbler, resulting in golden-winged warbler population declines since
 1631 the 1940s (NHESP 2015d). Full reasons for their decline are still not fully understood, as blue-winged
 1632 warbler numbers also have been declining since the 1980s and suitable golden-winged warbler nesting
 1633 habitat is not a limiting factor. It is possible that habitat declines in their wintering areas or cowbird
 1634 parasitism could be part of the problem (NHESP 2015d).

1635 ***Blanding’s Turtle***

1636 Blanding’s turtle has not been detected at Sagamore Hill, and the habitat is of marginal quality for this
 1637 species; therefore, they are unlikely to breed on Sagamore Hill. Furthermore, they have not been detected
 1638 within the town of Hamilton (Town of Hamilton 2009), and CEMML (2022b) did not detect any Blanding’s
 1639 turtle eDNA during surveys in 2022.

1640 ***Blue-Spotted Salamander***

1641 CEMML (2022b) ~~weakly~~ detected weakly signs of blue-spotted salamander eDNA in wetland A (in the
 1642 south-central portion of the installation) and wetland F (in the northeastern corner) on Sagamore Hill;
 1643 ~~however~~however, follow up surveys were not conducted due to resource limitation. MassWildlife (2021)
 1644 reported that this species was last observed at Sagamore Hill in 1996. There is suitable wetland habitat
 1645 throughout the site and additional cover object, or drift-fence surveys should be conducted to determine the
 1646 presence of this species. In 2019, blue-spotted salamander was confirmed in the town of Hamilton (Town
 1647 of Hamilton 2009; NHESP 2021b).

1648 **Fourth Cliff Recreation Annex**

1649 Nine listed species are confirmed or have the potential to occur at 4th Cliff, and there are eight protected
 1650 marine species that may inhabit the site’s surrounding waters (

Table 2-8. Threatened and endangered species and species of concern confirmed or potentially present at Fourth Cliff Recreation Annex.

1651). For species already described above in the sections for HAFB or Sagamore Hill, only their presence and
1652 suitable habitat at 4th Cliff will be discussed in this section. State-designated “Priority Habitat” 1065 and
1653 “Estimated Habitat” 818 (1065 and 818 are unique identifiers for specific polygons present at 4th Cliff) for
1654 rare species are located on all coastal shoreline areas and waters surrounding 4th Cliff ([Figure 2-7](#)). The
1655 only area not designed as Priority or Estimated Habitat is the main developed area of 4th Cliff. These
1656 designated habitats require project review by NHESP under MESA and the Massachusetts Wetlands
1657 Protection Act (MassGIS 2021). The unique habitat identifier numbers should be provided to NHESP
1658 during project reviews. The polygons for both habitat types overlap exactly at 4th Cliff.

1659

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Table 2-8. Threatened and endangered species and species of concern confirmed or potentially present at Fourth Cliff Recreation Annex.

Species	Scientific Name	Listing Category ¹	Status on Unit
<i>Mammals</i>			
Eastern small-footed bat	<i>Myotis leibii</i>	SE	Confirmed
Northern long-eared bat	<i>Myotis septentrionalis</i>	FT & FE**	Potential
Tricolored bat	<i>Perimyotis subflavus</i>	SE & PE	Confirmed
<i>Birds</i>			
Common tern	<i>Sterna hirundo</i>	SSC	Confirmed
Least tern	<i>Sternula antillarum</i>	SSC	Confirmed
Piping plover	<i>Charadrius melodus</i>	FT	Confirmed
Red knot	<i>Calidris canutus rufa</i>	FT	Confirmed
Roseate tern	<i>Sterna dougallii dougallii</i>	FE	Potential
<i>Reptiles</i>			
Eastern box turtle	<i>Terrapene carolina</i>	SSC	Potential
<i>Marine Species</i>			
<i>Mammals</i>			
Finback whale	<i>Balaenoptera physalus</i>	FE	Potential
North Atlantic right whale	<i>Eubalaena glacialis</i>	FE	Potential
<i>Reptiles</i>			
Green turtle	<i>Chelonia mydas</i>	FE	Potential
Kemp's Ridley turtle	<i>Lepidochelys kempii</i>	FE	Potential
Leatherback turtle	<i>Dermochelys coriacea</i>	FE	Potential
Loggerhead turtle	<i>Caretta caretta</i>	FE	Potential
<i>Fish</i>			
Atlantic sturgeon	<i>Acipenser oxyrinchus</i>	FE	Potential
Shortnose sturgeon	<i>Acipenser brevirostrum</i>	FE	Potential

1660 ¹ FE=Federally Endangered, FT=Federally Threatened, SE=State Endangered, ST=State Threatened,
 1661 SSC=Massachusetts Species of Special Concern.



1662
 1663

Figure 2-7. Priority habitat and estimated habitat for rare species on Fourth Cliff Recreation Annex.

1664 **Bats**

1665 The northern long-eared bat is potentially present at 4th Cliff (USFWS 2021c); however, the lack of
 1666 roosting habitat or confirmation during surveys in 2017 (Schwab 2018) indicate that they are unlikely to
 1667 use 4th Cliff extensively, except maybe for foraging. As discussed in the HAFB section above, they were
 1668 ~~auto-classified~~auto classified by the acoustic software at 4th Cliff, but not confirmed manually during
 1669 recording reviews; ~~thus~~thus, they cannot be definitively confirmed as absent from 4th Cliff (Schwab 2018).
 1670 Surveys should continue before confirming that they are absent from 4th Cliff. The nearest known northern
 1671 long-eared bat hibernaculum is approximately 30 miles away (NHESP 2021a).

1672 Eastern small-footed bat (*Myotis leibii*) and tricolored bat were confirmed at 4th Cliff in 2017 (Schwab
 1673 2018); however, at 4th Cliff only foraging habitat and small patches of deciduous trees and buildings are
 1674 available for roosting bats. The eastern small-footed bat is the smallest myotis species in the eastern U.S.,
 1675 and its life history is not as well documented as that of northern long-eared bat, little brown bat, and
 1676 tricolored bat; however, they seem to share the habits of using humid caves and mines as winter hibernacula
 1677 and foraging in summer around forests, open fields, wetlands, and riparian areas. Eastern small-footed bats
 1678 also appear to use buildings for summer roosts. Unlike northern long-eared bat, tricolored bats, and little
 1679 brown bat, the eastern small-footed bat has not been significantly impacted by white-nose syndrome
 1680 (NatureServe 2022d). Major threats are human disturbance to caves and hibernacula, habitat loss and
 1681 fragmentation, and collisions with wind turbines (NHESP 2019a).

1682 **Shorebirds**

1683 The piping plover and least tern are known to breed on the barrier beach on the western side of 4th Cliff
 1684 (Mostello et al. 2019, Walker et al. 2020), and the ~~federally-threatened~~federally threatened red knot has
 1685 been documented as staging on the 4th Cliff barrier beach during migration (HAFB 2019b, Jorgenson et al.
 1686 2019). The common tern and roseate tern (*Sterna dougallii dougallii*) are expected to stage and/or
 1687 potentially nest at 4th Cliff but only the former has been confirmed there (Mostello 2011, 2012, 2013, 2014;
 1688 Mostello and Longsdorf 2016a, 2017; Mostello et al. 2018, 2019; MassWildlife 2021; USFWS 2021c).
 1689 Shorebirds are present from late March to September during breeding season and fall migration, and they
 1690 use barrier beach habitat for both resting and foraging.

1691 Declines in shorebird populations are linked to habitat loss from coastal development, sea level rise
 1692 associated with climate change, shoreline stabilization, beach nourishment, and impacts to consistent food
 1693 sources at migration stopover sites (NHESP 2015g, 2015h, 2016b; Iglecia and Winn 2021). The numbers
 1694 of breeding shorebirds and breeding productivity are low at 4th Cliff, where the amount of habitat available
 1695 and predation on chicks are considered limiting factors (HAFB 2014). Piping plover census data show that,
 1696 from 2011–2019, a cumulative total of 12 pairs nested at 4th Cliff, successfully fledging 11 chicks in that
 1697 period; the highest count of plover pairs in any one year was three in 2017 and, the greatest total productivity
 1698 was three chicks in 2013 and in 2019; no chicks fledged in 2012, 2015, 2017, and 2018 (Melvin 2013, 2014;
 1699 Mostello et al. 2015; Mostello and Longsdorf 2016b; Levasseur et al. 2018a, 2018b; Regosin et al. 2018;
 1700 Walker 2019; Walker et al. 2020). Annual surveys show consistent presence of breeding pairs of least terns
 1701 at 4th Cliff but no breeding pairs of roseate or common terns (Mostello et al. 2019, HAFB 2019c, Jorgenson
 1702 et al. 2019). Finally, Jorgenson et al (2019) noted a large decrease in numbers of red knots staging at 3rd
 1703 and 4th Cliffs from a high count of 2,800 in 1981 to a high count of 7 in 2015. Red knot declines have been
 1704 linked to overharvesting of horseshoe crabs in ~~the Delaware~~Delaware Bay in the early 2000s (Niles et al.
 1705 2007).

1706 ***Eastern Box Turtle***

1707 Presence of eastern box turtle has not been confirmed at 4th Cliff and the limited amount of suitable habitat
1708 suggests that they would be unlikely to use the area. In 2018, however, the species was documented in the
1709 town of Scituate (NHESP 2021b).

1710 ***Marine Species***

1711 Several ~~federally listed~~federally listed marine species were identified on the NOAA Fisheries' online
1712 USESA Section 7 Mapper as potentially present in waters surrounding 4th Cliff (NOAA 2021);

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Table 2-8. Threatened and endangered species and species of concern confirmed or potentially present at Fourth Cliff Recreation Annex.

1713). These species are unlikely to be impacted during routine use of the 4th Cliff; however, they will need to
1714 be considered in any proposed construction projects involving water access.

1715 **2.3.4.4 Climate Impacts on Threatened, Endangered, and Species of Special Concern**

1716 CEMML (2022a) conducted population-level climate change vulnerability assessments for 21 species of
1717 conservation concern that have been confirmed or have the potential to occur on HAFB and its GSUs. These
1718 include federal and state T&E species, species under review and candidate species for listing under the
1719 USESA, USFWS birds of conservation concern, United States Forest Service Sensitive Species, and
1720 MassWildlife SSC and species of greatest conservation need. CEMML summarized the species'
1721 vulnerabilities to climate change (i.e., vulnerability risk) and the overall level of confidence associated with
1722 that risk, based on all available information. Additionally, narrative descriptions ~~are provided~~ of the
1723 evidence used to arrive at the vulnerability ratings are provided. Further information on vulnerability
1724 assessments can be found in the CEMML Climate Assessment (CEMML 2022a).

1725 In addition to the species-specific pressures described in the sections below, habitat change and disruption
1726 to food availability threaten all species at HAFB and will therefore be important considerations for all
1727 species of concern. Habitat requirements for some species, such as the need for refugia, may change as
1728 individuals adapt their behavior. Changes in temperature and precipitation may also affect prey populations
1729 or forage abundance for many species.

1730 ***Northern Long-Eared Bat (*Myotis septentrionalis*)***

1731 Bats may be among the most sensitive species to climate change and serve as early-warning indicators of
1732 large-scale ecological effects resulting from further regional warming and drying trends (Adams 2010,
1733 Cornman 2014). Although warming temperatures and increasing precipitation could benefit bats if they
1734 promote greater food availability and faster juvenile development, disruption of hibernation, extreme
1735 weather events, and spread of disease may cause significant mortality (Sherwin et al. 2012). Due to their
1736 declining populations, and susceptibility to white-nose syndrome and climate change-related impacts, the
1737 northern long-eared bat assessment resulted in a very high climate change vulnerability categorization.

1738 ***Tricolored Bat (*Perimyotis subflavus*)***

1739 Due to their declining populations, and susceptibility to white-nose syndrome and climate change-related
1740 impacts, tricolored bats were given a very high climate change vulnerability categorization.

1741 ***Little Brown Bat (*Myotis lucifugus*)***

1742 Although the little brown bat still retains a wide range across North America, their populations have
1743 ~~undergone declined dramatically declines~~ and they are highly susceptible to white-nose syndrome, which
1744 may be exacerbated by projected increases in temperature, resulting in a very high climate change
1745 vulnerability categorization.

1746 ***Eastern Small-footed Bat (*Myotis leibii*)***

1747 Although long-term population trends for the eastern small-footed bat are unknown, they are rarely found
1748 in large numbers ~~yet~~ but their populations remain stable. The small population size and patchy distribution
1749 of eastern small-footed bats increases their susceptibility to climate-related impacts such as droughts and

1750 severe weather events, yet they do not seem to be impacted by white-nose syndrome like other bat species,
1751 resulting in a moderate climate change vulnerability categorization.

1752 ***Peregrine Falcon (Falco peregrinus)***

1753 Peregrine falcons are a globally distributed raptor that have been confirmed on 4th Cliff. With the
1754 widespread use of chemical pesticides in the mid-1990s, peregrine falcon populations declined
1755 dramatically, but under federal protection, their populations have recovered (Mesta 1999, White et al. 2020,
1756 NatureServe 2022h). Peregrine falcons have a wide distribution across multiple habitats and increasing
1757 populations in multiple regions across their range, resulting in a low climate change vulnerability
1758 categorization.

1759 ***Ruffed Grouse (Bonasa umbellus)***

1760 Ruffed grouse are a medium-sized non-migratory land fowl that has been observed at Sagamore Hill. In
1761 many areas ruffed grouse populations are limited by forest succession (Porter and Jarzyna, 2013, Rusch et
1762 al. 2020, NatureServe 2022k). Due to forest maturation, ruffed grouse populations are declining in the
1763 eastern portion of their range, with a 54 percent decline in New York since the 1950s (Skrip et al. 2011,
1764 Rusch et al. 2020, NatureServe 2022k). Although little is known about how climate change may impact
1765 ruffed grouse, Perктаş (2021) projected populations to shift northward and become more widely distributed
1766 in the next 30–50 years. Despite population decreases in the northeastern U.S., the species has an abundant
1767 and secure population with a wide distribution that is expected to increase in the future, resulting in a low
1768 climate change vulnerability categorization.

1769 ***Common Loon (Gavia immer)***

1770 The common loon is a predominantly piscivorous diving bird that has been confirmed on 4th Cliff. This
1771 species is long-lived, with delayed maturity and low fecundity (Paruk et al. 2021), which decreases its
1772 ability to quickly recover from population declines. Although common loons have maintained a relatively
1773 stable population across their entire range, the northern part of their range has contracted over the past 100-
1774 150 years, with several northern U.S. states no longer supporting breeding populations (NatureServe
1775 2022c). Common loons were extirpated from Massachusetts in the early 1900s, but began to recolonize the
1776 area by 1975 (Paruk et al. 2021). Predominant reasons for common loon declines are mercury poisoning,
1777 acid rain, water level fluctuations, and human development and disturbance along freshwater shorelines
1778 (Stone and Okoniewski 2001, Warden 2010, Windels et al. 2013, Bianchini et al. 2020, Paruk et al. 2021).
1779 Despite recent common loon declines, particularly in the northeast U.S., causes of their decline have not
1780 been linked to climate-related changes and they currently have a stable population estimated at 600,000-
1781 800,000 individuals (Paruk et al. 2021), resulting in a low climate change vulnerability categorization.

1782 ***Least Tern (Sterna antillarum)***

1783 Least terns are known to breed on the barrier beach of 4th Cliff. Historical distribution and abundance of
1784 least terns are poorly documented, but their population declined significantly ~~underwent significant declines~~
1785 from egg collectors and plume hunters in the late 19th century (Draheim et al. 2012, Thompson et al. 2020).
1786 Additionally, the North American Breeding Bird Survey indicated further declines in the 1970s–80s (Sauer
1787 and Droege 1992). The causes of past population declines have been habitat destruction, human
1788 modification of river flow, severe weather events, and changes in prey availability, rather than climate
1789 change (Grover and Knopf 1982, USFWS 2013b, Thompson et al. 2020, NatureServe 2022f). Population
1790 abundance and distribution has increased since the 1980s (E. M. Kirsch and Sidle 1999, Lott 2006, USFWS
1791 2013b). Least terns that nest on the coast are also under increased risk from sea level rise. Additionally,
1792 nesting colonies may be negatively affected by increasing temperatures, although this is not projected to

1793 cause catastrophic recruitment failure (USFWS 2013b). The ability of least terns to adapt to changes in
1794 habitat availability and quality, as well as stochastic weather and hydrologic events, indicates that they may
1795 be relatively resistant to projected changes in climate (USFWS 2013b, 2021b). In combination with their
1796 wide distribution and increasing populations, this resulted in a moderate climate change vulnerability
1797 categorization for least terns.

1798 ***Common Tern (Sterna hirundo)***

1799 The common tern is a long-distance migrant that has been confirmed on 4th Cliff. It is the most widespread
1800 and familiar tern in North America, breeding throughout temperate Europe and Asia and in inland locations
1801 across Canada and northern U.S. (Arnold et al. 2020). The population of common terns is declining in
1802 certain regions, including parts of the northeastern U.S., but overall is stable or increasing throughout much
1803 of its range (Palestis and Hines 2015, Arnold et al. 2020). One climate-related concern for common tern is
1804 sea level rise. Current Department of Defense Regional Sea Level data projects a sea-level rise of 1.6–8.5
1805 feet by 2100 (Hall et al. 2016), which could negatively impact common tern breeding populations. Although
1806 common tern populations underwent a dramatic decline in the past, their populations have increased
1807 dramatically across their range and they are not highly susceptible to climate-related impacts, resulting in
1808 a low climate change vulnerability categorization.

1809 ***Upland Sandpiper (Bartramia longicauda)***

1810 The upland sandpiper has been confirmed in grassland habitats on HAFB. Although still numerous, their
1811 populations have undergone significant declines over the last 150 years due to habitat loss and degradation,
1812 over-hunting, pesticides, and depredation (Osborne and Peterson 1984, Houston 1999, Houston et al. 2020,
1813 NatureServe 2022m). Although climate change has not been directly implicated in past declines, the extent
1814 of the grassland habitat upland sandpipers depend on is expected to decrease due to climate change (Shafer
1815 et al. 1987, Bagne et al. 2012, Glaser 2014). Recent analysis suggests upland sandpipers are highly
1816 vulnerable to temperature and/or moisture changes, thus making their populations more vulnerable to
1817 projected changes in climate (Culp et al. 2017). Upland sandpiper populations in many areas are declining
1818 and they are susceptible to climate-related impacts such as increases in temperature, flooding, and sea level
1819 rise, yet they are highly mobile and retain a wide distribution across the U.S., resulting in a moderate climate
1820 change vulnerability categorization.

1821 ***American Woodcock (Scolopax minor)***

1822 The American woodcock is a forest-dwelling shorebird that has been documented on Sagamore Hill.
1823 Similar to ruffed grouse, American woodcock populations have declined significantly throughout their
1824 range since 1968 (Kelley et al. 2008, Seamans and Rau 2021). Despite their population decline, American
1825 woodcocks have maintained their wide distribution, have an estimated population size of over three million
1826 (NatureServe 2022b), and major causes of their decline have not been climate-related, resulting in a low
1827 climate change vulnerability categorization.

1828 ***Piping Plover (Charadrius melodus)***

1829 Piping plovers are known to breed on the barrier beach on 4th Cliff. Sea level rise, storm surge, and
1830 increases in the frequency and intensity of storms are climate-related threats to piping plover populations
1831 (USFWS 2012, NatureServe 2022i). Sea level rise is projected to inundate these areas, but new habitat
1832 may be created where beaches can naturally migrate inland. However, Galbraith (2002) suggested that a
1833 delay between habitat loss and habitat creation can lead to further population declines. Loss of habitat to
1834 sea level rise also may result in disproportionately large population declines because migration stopovers
1835 receive concentrated use and are already unable to support existing shorebird populations (Iwamura et al.

1836 2013). There are no modeled projections for piping plover population trends under climate change
 1837 scenarios, but their low abundance, declining population, and sensitivity to sea ~~level~~ rise resulted in a
 1838 very high climate change vulnerability categorization.

1839 ***Red Knot (Calidris canutus rufa)***

1840 Red knots have been confirmed on 4th Cliff during their migration. ~~They have undergone p~~Populations
 1841 ~~have declines declined~~ of more than 90 percent in recent decades, which ~~have has~~ been particularly well
 1842 documented at migratory stopover sites (Baker et al. 2020). These declines are primarily the result of human
 1843 activities, such as habitat destruction and overharvesting of the species' prey, horseshoe crabs (USFWS
 1844 2013c, 2014, 2020; Baker et al. 2020; NatureServe 2022j). Additionally, projected sea level rise and
 1845 changes in tidal conditions are likely to reduce the occurrence of intertidal habitat used by the red knot,
 1846 which could lead to reduced foraging habitat and prey (USFWS 2014). Limited information is available
 1847 about this species, and the ability to determine whether observed declines are attributable to climate change
 1848 is low. Despite the red knot's susceptibility to changes in climate, they still retain a large distribution with
 1849 a relatively large abundance, resulting in a low climate change vulnerability categorization.

1850 ***Grasshopper Sparrow (Ammodramus savannarum)***

1851 The grasshopper sparrow has been confirmed on HAFB. The largest threats to grasshopper sparrow
 1852 populations are habitat loss, habitat degradation, and incompatible grassland management (Ehrlich et al.
 1853 1992, Slater 2004, NatureServe 2022e). Increases in temperature and frequency of extreme events (e.g.,
 1854 droughts, flooding, and storms) associated with climate change could negatively impact grasshopper
 1855 sparrow populations (Ruth 2015), especially since populations were positively correlated with May
 1856 precipitation in some areas (Ahlering et al. 2009). Despite the potential negative impacts of climate change,
 1857 grasshopper sparrows have a wide distribution and relatively stable population size, resulting in a low
 1858 climate change vulnerability categorization. Grasshopper sparrows have also been predicted to have a low
 1859 vulnerability to climate change by other researchers (Hoving et al. 2013; Wilsey et al. 2019).

1860 ***Wood Turtle (Glyptemys insculpta)***

1861 The wood turtle has the potential to occur on HAFB. Wood turtles are declining across much of their range;
 1862 however, the rate of decline is predicted to be much higher in New England (van Dijk and Harding 2011,
 1863 Willey et al. 2022). Although habitat loss and fragmentation can negatively impact wood turtle populations,
 1864 overharvesting for the pet trade is considered the major reason for their decline (NatureServe 2022n). A
 1865 recent habitat suitability study by Mothes et al. (2020) predicted that suitable habitat for wood turtles could
 1866 decrease by 29–52 percent by 2070. They predicted that rising temperatures may shift the turtle's range
 1867 northward and that areas in Maine, Vermont, New Hampshire, and New York are where the majority of
 1868 climate refugia exist (Mothes et al. 2020). Although main causes of wood turtle decline have not been
 1869 related to climate, their populations have been decreasing rapidly, their life history traits make them
 1870 vulnerable to decline and slow to recover, and their habitat suitability is projected to decline in the future
 1871 due to increasing temperatures, resulting in a moderate climate change vulnerability categorization.

1872 ***Eastern Box Turtle (Terrapene carolina)***

1873 The Eastern box turtle has the potential to occur on HAFB and 4th Cliff. The species has a wide range
 1874 across much of the Eastern U.S. and can be found in a variety of habitats, including forests and fields, often
 1875 using pools of shallow water in summer (NatureServe 2022a). Eastern box turtle populations have declined
 1876 in some areas, primarily due to habitat loss, disease, and over-collection (NatureServe 2022a). Despite
 1877 declines in their population, they retain a wide distribution and a relatively secure population size, resulting
 1878 in a low climate change vulnerability categorization.

1879 ***Blanding's Turtle (Emydoidea blandingii)***

1880 The Blanding's turtle has the potential to inhabit HAFB and Sagamore Hill. Blanding's turtles are declining
 1881 across their range (Congdon et al. 2000, Beaudry et al. 2010, Jones and Sievert 2012). Their reliance on
 1882 aquatic habitat makes them vulnerable to droughts and increased temperatures. Additionally, temperatures
 1883 are a key factor in nest site selection and increased temperatures have led to earlier initiation of nesting in
 1884 some regions (Byer et al. 2020). While Blanding's turtles maintain a relatively large population size and
 1885 wide distribution, climate change may shift their suitable habitat northward, resulting in a moderate climate
 1886 change vulnerability categorization.

1887 ***Blue-spotted Salamander (Ambystoma laterale)***

1888 The blue-spotted salamander has been confirmed on HAFB and Sagamore Hill. Little is known about how
 1889 this species may be impacted by climate change, but due to its aquatic nature and reliance on aquatic
 1890 habitats, it is susceptible to droughts and temperature increases. Despite these possible impacts, their current
 1891 population is considered stable and major threats to their populations have not been associated with climate,
 1892 resulting in a low climate change vulnerability classification.

1893 ***Monarch Butterfly (Danaus plexippus plexippus)***

1894 Monarch butterfly have the potential to occur on HAFB and its GSUs. Studies have indicated that climate
 1895 is a major driver of the species' population dynamics (Barve et al. 2012, Zipkin et al. 2012). Therefore,
 1896 projected climate change scenarios, such as increased drought and altered timing and magnitude of weather
 1897 events, could have substantial effects on monarch populations (Barve et al. 2012, Zipkin et al. 2012).
 1898 Multiple ecological niche models have predicted that monarch populations will decline further due to
 1899 climate-related impacts and habitat loss in both their winter and summer ranges (Oberhauser and Peterson
 1900 2003, Batalden et al. 2007, Barve et al. 2012). Due to their recent dramatic declines and high susceptibility
 1901 to climate-related extreme weather events and droughts, monarch butterflies were given a very high
 1902 vulnerability categorization.

1903 ***Yellow-banded Bumble Bee (Bombus terricola)***

1904 Yellow-banded bumble bees have the potential to occur on HAFB and its GSUs. Due to their steep
 1905 population decline and susceptibility to multiple threats (e.g., disease, pesticide, invasive species; USFWS
 1906 2018b, NatureServe 2022o) yellow-banded bumble bees are increasingly vulnerable to the impacts of
 1907 climate change, yet they retain a wide distribution across North America, thus resulting in a moderate
 1908 vulnerability categorization.

1909 ***Small-whorled Pogonia (Isotria medeoloides)***

1910 The small-whorled pogonia is a widely, but sparsely, distributed perennial herb that has the potential to
 1911 occur on Sagamore Hill. Small-whorled pogonias occur in small, rarely found populations within open
 1912 patches of mixed woodlands, often secondary growth (Brumback et al. 2011, NatureServe 2022i). Little
 1913 information is available about population trends and climate-related impacts to this species, but occurrences
 1914 of small-whorled pogonia have decreased over time and there are less than 300 estimated total occurrences
 1915 (NatureServe 2022i). According to MassWildlife, there used to be seven populations within the state but
 1916 only five remain (MassWildlife 2015b). Although major threats to small-whorled pogonias have not been
 1917 climate-related, their extremely small population size and patchy distribution increase their susceptibility
 1918 to future climate-related impacts such as extreme weather events, thus resulting in a moderate climate
 1919 change vulnerability categorization.

1920 2.3.5 Wetlands and Floodplains

1921 The definitions and criteria for determining the presence of wetlands under the federal Clean Waters Act
 1922 (33 U.S.C. 1344, s.404) and the Massachusetts Wetlands Protection Act (MGL c.131, s. 40) and its
 1923 implementing regulations (310 Code of Massachusetts Regulations 10.00) were used to identify wetlands
 1924 at HAFB, Sagamore Hill, and 4th Cliff. To identify floodplains, FEMA provides Flood Insurance Rate
 1925 Maps, which overlay official community maps with special flood hazard areas (FEMA 2022).

1926 Hanscom Air Force Base

1927 At HAFB, there are freshwater wetlands characterized by trees and shrubs that are classified as wooded
 1928 swamp deciduous, wooded swamp mixed trees, and shallow marsh mallow (*Althaea officinalis*) vegetation
 1929 types. There is a designated floodway for the Shawsheen River on the base, signifying that the stream
 1930 channel and any adjacent floodplains must be kept free of encroachments so that a 100-yr flood can be
 1931 accommodated without substantial increases in flood depths. There is also a SFHA for North Lexington
 1932 Brook that slightly encroaches on a small portion of the base during a 100-year flood (see [Figure 2-8](#)).

1933 Fourth Cliff Recreation Annex

1934 Wetland resources at 4th Cliff include salt marsh, coastal dune, coastal bank, coastal beach, land under the
 1935 ocean, rocky intertidal shores, barrier beach, and anadromous/catadromous fish run. These protected coastal
 1936 resources extend throughout the 4th Cliff site, particularly the eastern and southeastern lower-lying
 1937 portions, placing a considerable constraint on further development outside of the limited upland areas (LEC
 1938 Environmental Consultants, Inc. 2008a). The site is located within a 100-year flood SFHA and coastal
 1939 barrier resource area (FEMA 2022). As such, the surrounding coastal area is at a very high risk of flooding.

1940 Sagamore Hill Solar Weather Observatory Annex

1941 Small wetlands are present on Sagamore Hill, consisting primarily of forested wetlands that occur to the
 1942 east of the buildings and antenna structures (LEC Environmental Consultants Inc. 2008a). Wetlands have
 1943 been labelled A–E and these letters are referenced throughout this INRMP when discussing wildlife surveys
 1944 in Sagamore Hill wetlands (see [Figure 2-9](#)).

1945 2.3.5.1 Climate Impacts to Wetlands and Floodplains

1946 Wetlands and floodplains are particularly sensitive to changes in climate as they support diverse
 1947 assemblages of species and provide important ecosystem services. Rising temperatures may contribute to
 1948 increased rates of evapotranspiration and drying, but also increase the moisture holding capacity of the
 1949 atmosphere affecting storm formation, duration, and intensity. Reduced rainfall under drought conditions
 1950 reduces surface water runoff and infiltration, affecting recharge of shallow aquifer systems, especially
 1951 common in glacial deposits, resulting in reduced contributions from springs and seeps to wetlands and
 1952 baseflow to stream systems. Summer low flows events are expected to increase in magnitude, becoming
 1953 more severe, especially under increasing emissions (Siddique et al. 2020). The seasonality inherent to the
 1954 region is also becoming reduced, with winter warming trends outpacing summer warming trends which
 1955 may change the timing of hydrologic processes, such as spring melt-out and subsequent streamflow
 1956 (Siddique et al. 2020, Young and Young 2021).

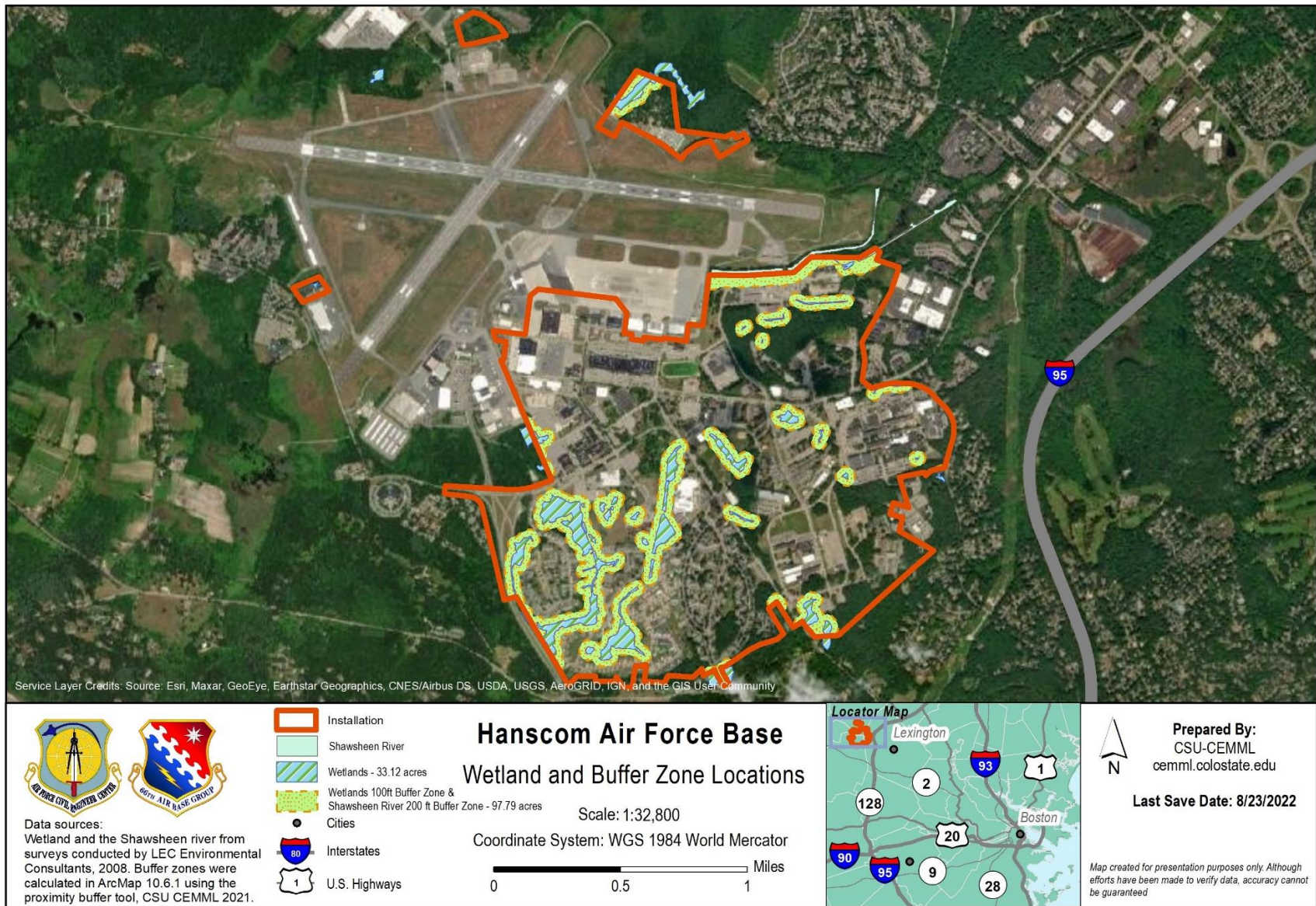
1957 Trends in precipitation in Massachusetts and the greater Northeastern US have shown increases in total
 1958 amount, with a majority of contribution from rain falling in the summer months (Kunkel et al. 2020).
 1959 Extreme precipitation events are becoming more common, even for events of smaller durations (fewer days)
 1960 and return intervals (more frequent events) as studied in the precipitation analyses for HAFB (Kunkel et al.
 1961 2020). Increasing trends in more extreme precipitation events, such as those that contribute to 100-year

1962 flood events have ~~occure~~occurred and are expected to intensify under a changing climate, which can
1963 damage floodplains, associated wetlands, and infrastructure (MEMA and EOEEA 2018, Kunkel et al. 2020,
1964 Siddique et al. 2020). Precipitation released by storms increased 17 percent during the past half-century,
1965 correlating with an increased frequency of federally declared disaster events (MEMA and EOEEA 2018).

1966 Storm events that combine riverine flooding and coastal flooding are particularly damaging to estuarine
1967 stream corridors and outlets to the open ocean, reducing buffering effects of streamside wetlands and coastal
1968 wetland vegetation through inundation and erosion, with probability of increases in these types of events
1969 expected with rising sea levels (Ghanbari et al. 2021). The effects of increasingly intense hurricanes and
1970 nor'easters combined with sea level rise will increase risks from storm surge, especially that associated
1971 with wave runup-induced splashing and overtopping which will impact lower-lying areas including beach
1972 areas and coastal wetlands (Chen et al. 2021).

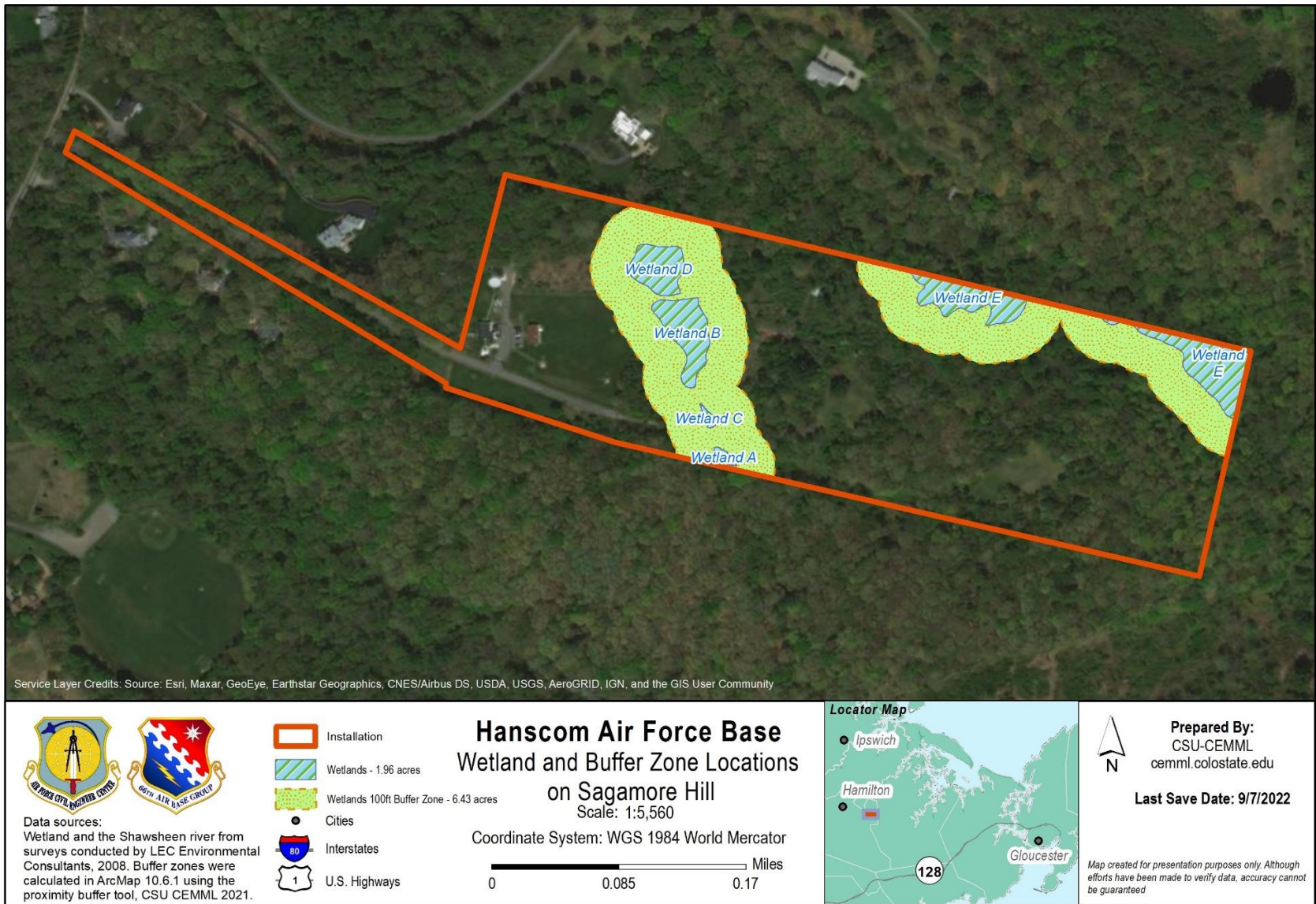
1973

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1974

1975 Figure 2-8. Wetlands and wetland buffer areas on Hanscom Air Force Base.



1976

1977 Figure 2-9. Wetland resources at Sagamore Hill Solar Weather Observatory.

1978 2.3.6 *Other Natural Resource Information*1979 ***Spotted lanternfly***

1980 The spotted lanternfly (*Lycorma delicatula*) is an invasive insect, native to East Asia, that feeds on plant
 1981 sap causing significant impacts to plants, specifically agricultural crops. This species was first detected in
 1982 the northeastern U.S. in 2014 and has spread to several states, including Massachusetts. As of June 2022,
 1983 this species has not been reported on HAFB or the GSUs, however, a common spotted lanternfly host plant
 1984 tree-of-heaven (*Ailanthus altissima*) — also an invasive species — is present on HAFB (CEMML 2022c).

1985 The Armed Forces Pest Management Board (2021) released guidance for the component forces on the need
 1986 for an early detection and rapid response plan for spotted lanternfly IAW DoDI 4150.07, *DoD Pest*
 1987 *Management Program*, and Executive Orders 13112 and 13751. DoDI 4150.07 and the executive orders
 1988 require federal agencies to prevent invasive species introductions and control existing invasive species. If
 1989 spotted lanternfly were to establish, the potential mission impacts include natural and cultural resource
 1990 degradation, management action requirements, and quarantine issues (CEMML 2022c). Recommended
 1991 management actions are discussed in [Section 7.11](#).

1992 **2.4 Mission and Natural Resources**1993 **2.4.1 Natural Resource Constraints to Mission and Mission Planning**1994 **Hanscom Air Force Base**

1995 A majority of the stormwater runoff collected on HAFB is discharged into the headwaters of the Shawsheen
 1996 River, which runs along the northern edge of the base and flows northeast adjacent to ~~twelve~~ 12 towns. The
 1997 HAFB Stormwater Pollution Prevention Program, which was enacted to limit the amount of contaminated
 1998 stormwater that enters the Shawsheen River, places constraints on future development and vegetation
 1999 management around the wetlands adjacent to the headwaters (HAFB 2017a).

2000 The potential presence of northern long-eared bat, which is a ~~federally listed~~ federally listed species found
 2001 throughout New England, places additional constraints on activities at HAFB. Although the species has not
 2002 been detected at the main base, there have been confirmed sightings nearby in Middlesex County, which
 2003 led to a restriction being placed on removing trees at HAFB from April to August each year. This restriction
 2004 constrains future development at HAFB if ~~plans would~~ plans entail replacing forested sections with new or
 2005 modernizations of facilities, sidewalks, or roads.

2006 Another constraint on development at HAFB is presented by three Environmental Restoration, Quality, and
 2007 Munitions Response Program sites located in the northeastern section of HAFB that require open space for
 2008 safely storing waste products generated by HAFB mission activities. Development in these areas is limited
 2009 by the need to continue use of these sites and to minimize potential health hazards that they could present
 2010 to base personnel.

2011 Finally, the Hanscom Field runway apron covers a small portion of the base's northern edge. Some
 2012 development opportunities are precluded in this area to account for the Accident Potential Zone that flight
 2013 operations create (HAFB 2017a).

2014 Additional details on these constraints are discussed in the 2017 HAFB IDP.

2015 **Fourth Cliff Recreation Annex**

2016 The primary constraint on the mission at 4th Cliff is the current erosion that threatens some areas of the
 2017 peninsula where the recreational facilities are located. The site has a series of cliffs undergoing erosion at

2018 a rate of up to one foot per year, which permanently limits opportunities for development and recreation on
 2019 large sections of the peninsula and creates the need for continual erosion mitigation (HAFB 2014).
 2020 Recreational opportunities on the western beaches are also constrained by the presence of least tern and
 2021 piping plover nesting grounds, which are used from April to August each year (HAFB 2017a).

2022 **Sagamore Hill Solar Weather Observatory Annex**

2023 A majority of the Sagamore Hill land consists of wetland and upland forest habitats useful to the ~~federally-~~
 2024 ~~listed~~federally listed northern long-eared bat, which has been observed at this site. The verified presence of
 2025 northern long-eared bat has led to a restriction being placed on removing trees at Sagamore Hill from April
 2026 to October each year to protect the species. This restriction may inhibit future development planning. There
 2027 are also two wetland areas on site identified as potentially requiring protection because of their importance
 2028 to the surrounding areas, which further reduces the ability to develop or alter the land at Sagamore Hill.

2029 To ensure full solar-observation capabilities, Sagamore Hill also needs a clear line-of-sight to surrounding
 2030 areas. Although a majority of the surrounding area is undeveloped forest, some houses have been
 2031 constructed nearby, and increased future development around the site may limit the radar coverage (HAFB
 2032 2017a).

2033 **2.4.1.1 Potential Future Constraints due to Climate Change**

2034 The CEMML Climate Assessment (CEMML 2022a) identified several ways that climate change could
 2035 directly or indirectly affect the mission, mission-critical infrastructure, and natural resources. The HAFB
 2036 mission is moderately reliant on the natural environment and may be impacted indirectly by stressed or
 2037 shifting ecosystems, loss of ecosystem services, and increased regulatory burden if additional species are
 2038 listed. See [Section 7.16](#) for a more detailed discussion of climate change vulnerabilities to the mission and
 2039 operations at HAFB.

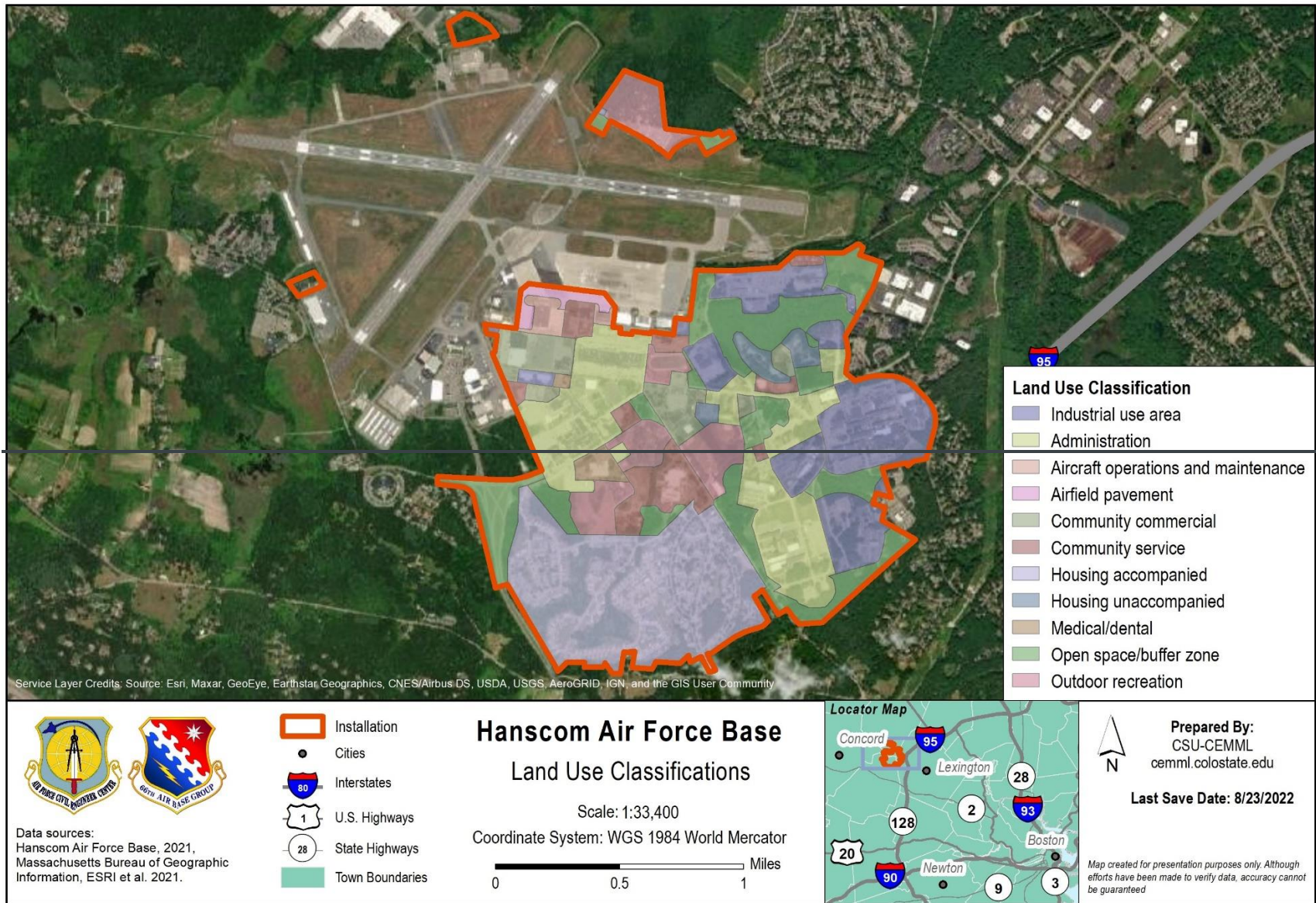
2040 **2.4.2 Land Use**

2041 **Hanscom Air Force Base**

2042 The 846-acre main base includes 713 acres that are developed or altered. These developed areas support
 2043 413 administrative and research facilities, 731 private housing units, sidewalks, and roads in nine distinct
 2044 districts ([Figure 2-10](#)).

2045 The 133 undeveloped acres comprise fragmented wetlands and upland forest. The wetland areas account
 2046 for 31 acres (3.7 percent of HAFB), the majority of which are fragmented into areas of less than one acre.
 2047 The forested areas account for 101 acres (17 percent of HAFB), most of which are fragmented into patches
 2048 of less than five acres (HAFB 2017a). Another five percent of the developed acreage is composed of altered
 2049 grasslands planted in small patches or strips adjacent to developed areas, including sidewalks and housing
 2050 units (LEC Environmental Consultants, Inc., 2007).

2051 At the HAFB Vision Workshop, participants identified nine districts on base, divided according to the
 2052 primary activities they support, including Housing (for military personnel), the MIT Lincoln Laboratory,
 2053 other Tenants, Base Support, Lodging (for visitors), Acquisitions, Community Outreach, Medical, and
 2054 Education. A majority of these districts are composed primarily of research and development facilities,
 2055 roads, and small fragmented sections of forest and wetland. The largest district identified is Housing, where
 2056 the 731 residential housing units are located on the southern section of the base. The primary land uses in
 2057 this district are housing, lawns, roads, and forested areas that provide a buffer zone for the smaller wetland
 2058 areas within the district and between the Housing and research districts (HAFB 2017a).



2059

2060 Figure 2-10. Land use classification at Hanscom Air Force Base.

2061 **Fourth Cliff Recreation Annex**

2062 The 56-acre 4th Cliff site is located along the end of the Humarock Peninsula. There are 22 developed acres
 2063 comprising open recreation areas, cottages, and roads on the upland section. The western edge and eastern
 2064 end of the peninsula are composed of undeveloped beaches, salt marshes, and sandy flats (LEC
 2065 Environmental Consultants, Inc., 2008a).

2066 **Sagamore Hill Solar Weather Observatory Annex**

2067 Sagamore Hill is a 32-acre site with only three developed acres on the western section where the entrance
 2068 and three main facilities are located. The remaining 29 acres are composed of forested uplands and wetlands
 2069 (LEC Environmental Consultants, Inc., 2008b).

2070 *2.4.3 Current Major Mission Impacts on Natural Resources*

2071 **Hanscom Air Force Base**

2072 Efforts associated with fulfilling the HAFB mission have resulted in a heavily developed main base
 2073 composed mainly of research and administrative facilities, residential and educational buildings, and roads
 2074 and jogging trails connecting the facilities. Due to the large amount of development, the remaining 133
 2075 acres of undeveloped land are composed of highly fragmented sections of wetland and forest that are too
 2076 small and fragmented to provide habitat for animal species that cannot adapt to human activity and
 2077 development. The impact of outdoor recreation on these areas is minimal because the majority of outdoor
 2078 recreation activities take place on jogging trails, and because access to wetland areas is restricted to HAFB
 2079 personnel.

2080 The 2008 Application of the Hanscom Natural Infrastructure Assessment identified HAFB as a major
 2081 source of air pollution resulting from the use of private cars and other mission-related activities. The base
 2082 currently has a Title V Air Permit, per the Clean Air Act, which allows for increased levels of air pollution
 2083 emissions. Even with these increased levels of pollution, however, HAFB still falls within the regulatory
 2084 standards of the bordering towns (Weston Solutions, Inc., 2008).

2085 The headwaters of the Shawsheen River are used as the primary conduit for stormwater removal. This
 2086 creates the need for stringent management of fertilizers used at HAFB to help reduce contamination of the
 2087 river (HAFB 2017a; see [Section 2.4.1](#)).

2088 **Fourth Cliff Recreation Annex**

2089 The developed upland section of 4th Cliff is currently losing one foot per year to erosion, which creates the
 2090 need for ongoing erosion mitigation to preserve the soil foundation (LEC Environmental Consultants, Inc.,
 2091 2008a). Although least tern and piping plover nesting habits are at risk of negative impacts from visitors,
 2092 potential impacts are mitigated by limiting recreational activity on a small portion of the site where nesting
 2093 and foraging is actively occurring during nesting seasons (HAFB 2017a).

2094 **Sagamore Hill Solar Weather Observatory Annex**

2095 Use of Sagamore Hill is limited to three observatory facilities (one radar structure and two buildings) and
 2096 a small parking lot on three acres of the western section. This limits mission impacts on the remaining 16
 2097 acres of wetland and forested area (HAFB 2017a).

2098 2.4.4 *Potential Future Mission Impacts on Natural Resources*2099 **Hanscom Air Force Base**

2100 The primary mission of HAFB is achieved primarily within the research and administration facilities
2101 throughout the northern half of the base, and the use of land and base facilities is not anticipated to change
2102 drastically in the foreseeable future. The continued use of present facilities and the planned modernization
2103 of several existing facilities, however, presents some potential conflicts with the natural resources at HAFB
2104 and its GSUs.

2105 The HAFB 2017 IDP identified 26 parcels of land that are open for development, many of them in or
2106 adjacent to forested or wetland sections of HAFB. The planned development in 21 of these areas has the
2107 potential to negatively impact the nearby environments through an increase in releases of harmful
2108 particulates during construction or by encroaching on the edges of some natural areas. The IDP does address
2109 this issue, and future development plans are focused on retaining the current state and composition of these
2110 natural areas, which will require mitigation work during periods of construction (HAFB 2017a).

2111 Because there is a high number of facilities and housing units on HAFB, the use of private vehicles on base
2112 also generates stormwater contamination and air pollution issues.

2113 Currently, there is a series of jogging trails throughout the base that effectively limit the use of undeveloped
2114 areas for recreation, although expanding these trails and adding bike lanes to diminish private vehicle use
2115 might further reduce the available undeveloped areas. Construction to alter the roads also has the potential
2116 to cause air-quality and noise issues (HAFB 2010).

2117 As discussed in [Section 2.4.3](#), HAFB is recognized as a source of excess air pollution in the area, and it is
2118 suggested by the 2008 Application of the Hanscom Natural Infrastructure Assessment that HAFB begin
2119 tracking base emissions so that mission activities aren't halted or stalled in the future by stricter air
2120 regulations or a change in mission activities (Weston Solutions, Inc., 2008).

2121 **Fourth Cliff Recreation Annex**

2122 Erosion is the most prominent natural resource issue at 4th Cliff, and if appropriate efforts are not made to
2123 mitigate the loss of the upland cliffs and monitor pedestrian and vehicular traffic in these areas, larger areas
2124 of 4th Cliff have the potential of being unavailable for recreation in the future. Educational programs are
2125 an important part of the 4th Cliff mission, as discussed in [Section 2.4.1](#), and the presence of threatened
2126 shorebirds like the piping plover and least tern provide unique and personal learning opportunities for
2127 visitors. At the same time, continued visitation to the shore areas used by these species may reduce the
2128 quality of their habitat if it is not carefully managed. There is also a need to continue monitoring the
2129 shorebird populations to ensure that negative impacts of visitors are mitigated. If proper management efforts
2130 are not taken, the populations of these species may be further diminished (HAFB 2014). [For projects related
2131 to the management and protection of plover habitats on recreational beaches, installation managers refer to
2132 the guidelines published by MassWildlife \(*Guidelines for Managing Recreational Use of Beaches to
2133 Protect Plovers, Terns and Their Habitats in Massachusetts*\) and USFWS \(*Guidelines for Managing
2134 Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast to Avoid Take Under
2135 Section 9 of the Endangered Species Act*\).](#)

2136

2137 **Sagamore Hill Solar Weather Observatory Annex**

2138 Sagamore Hill encompasses 16 undeveloped acres of wetland and forest that offer a unique refuge because
2139 mission activities are consolidated on the western section. This provides a useful and protected habitat for
2140 protected species, including northern long-eared bat. Currently there are no plans to alter site use; however,
2141 there is a proposal to replace the copper network cable that runs from Sagamore Hill to HAFB. Replacing
2142 the existing cable would require extensive digging that would at least temporarily alter the surrounding
2143 environment, from Sagamore to HAFB (HAFB 2017a).

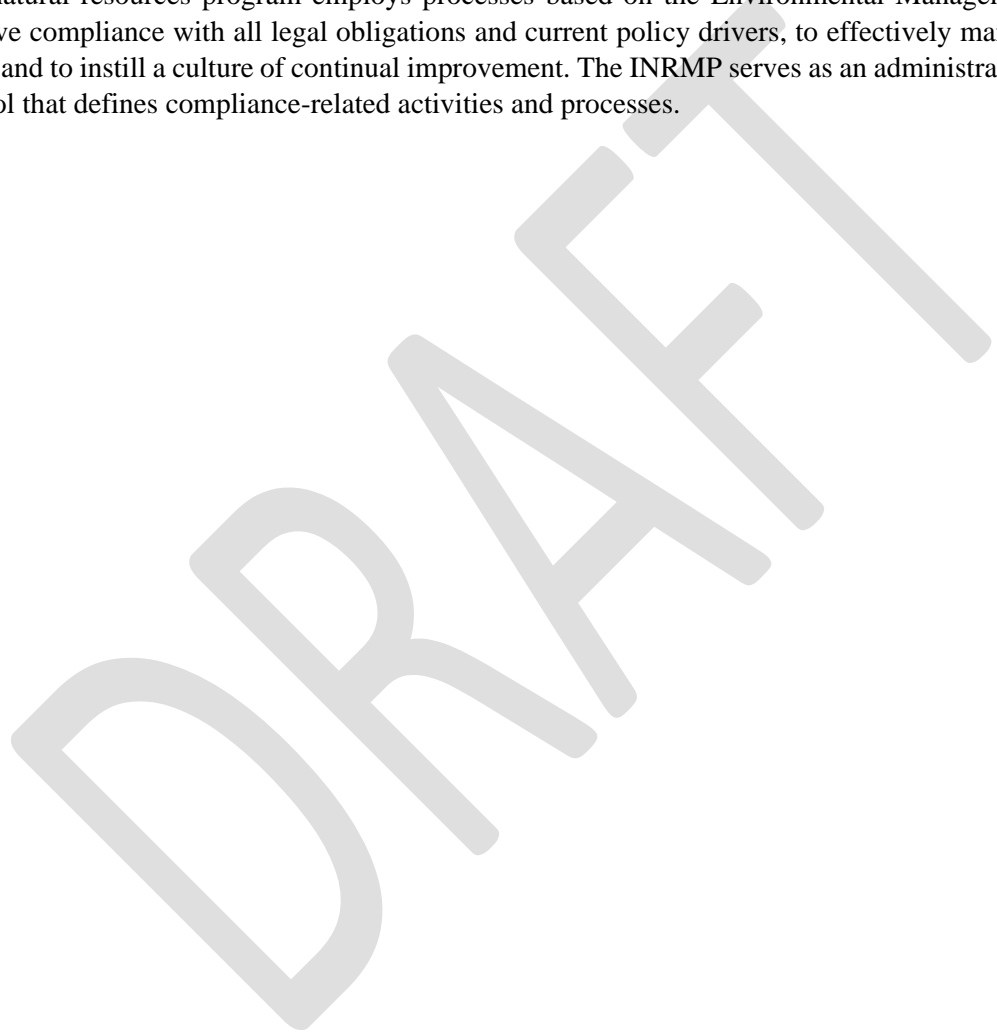
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2144 **3.0 ENVIRONMENTAL MANAGEMENT SYSTEM**

2145 The USAF environmental program adheres to the Environmental Management System framework and its
2146 “Plan, Do, Check, Act” cycle for ensuring mission success. EO 13834, *Efficient Federal Operations*; DoDI
2147 4715.17, *Environmental Management Systems*; AFI 32-7001, *Environmental Management*; and
2148 International Organization for Standardization 14001 standard, *Environmental Management System—*
2149 *Requirements with Guidance for Use*, provide guidance on how environmental programs should be
2150 established, implemented, and maintained to operate under the Environmental Management System
2151 framework.

2152 The natural resources program employs processes based on the Environmental Management System to
2153 achieve compliance with all legal obligations and current policy drivers, to effectively manage associated
2154 risks, and to instill a culture of continual improvement. The INRMP serves as an administrative operational
2155 control that defines compliance-related activities and processes.

2156



2157 **4.0 GENERAL ROLES AND RESPONSIBILITIES**

2158 General roles and responsibilities that are necessary to implement and support the natural resources program
 2159 are listed in [Table 4-1](#). Specific natural resources management-related roles and responsibilities are
 2160 described in appropriate sections of this plan.

Table 4-1. Hanscom Air Force Base organizations and their roles in INRMP implementation.

Office/Organization/Job Title (Listing is not in order of hierarchical responsibility)	Installation Role/Responsibility Description
Installation Commander	<ul style="list-style-type: none"> • Approves INRMP and certifies annual reviews and updates • Oversees the use of installation’s natural resources • Provides necessary staffing to execute INRMP implementation
Air Force Civil Engineer Center, Natural Resources Media Manager / Subject Matter Expert / Subject Matter Specialist	<ul style="list-style-type: none"> • Advocates for resources and funding needed to implement INRMP
66 ABG/Civil Engineer	<ul style="list-style-type: none"> • Provides landscape maintenance services • Manages Tree City USA Program • Ensures all work completed by Civil Engineer (CE) Services Contractor conforms to Massachusetts Department of Environmental Protection requirements, National Environmental Policy Act requirements, and applicable federal, state, and local policies and regulations
66 ABG/Environmental Management	<ul style="list-style-type: none"> • Reviews impacts on natural resources through CE work order and project reviews
66 ABG/Force Support Squadron	<ul style="list-style-type: none"> • Responsible for recreation and personnel support • Manages the Fourth Cliff Recreation Area and the Patriot Golf Course • Provides access to natural resources personnel requiring access to managed facilities
HAFB Environmental Safety and Occupational Health Council	<ul style="list-style-type: none"> • Ensures that commanders have a holistic view of separately managed and funded environmental programs • Ensures best practices across organizations • Streamlines program oversight
Installation Natural Resources Manager/Point of Contact	<ul style="list-style-type: none"> • Supports military mission by managing natural resources in accordance with laws and directives

Table 4-1. Hanscom Air Force Base organizations and their roles in INRMP implementation.

Office/Organization/Job Title (Listing is not in order of hierarchical responsibility)	Installation Role/Responsibility Description
	<ul style="list-style-type: none"> Coordinates INRMP updates and revisions with internal and external stakeholders
Installation Security Forces	<ul style="list-style-type: none"> Assists in investigating violations of Federal natural resources laws Advises the Commander on security measures related to natural resources Coordinates on requests to place remote monitoring devices for natural resource surveys on the installation
Installation Unit Environmental Coordinators (UEC); see AFI 32-7001 for role description	<ul style="list-style-type: none"> Advises the unit commander and unit personnel on issues related to environmental compliance and conservation Participates in UEC Working Group Meetings and the Environmental Management System Cross Functional Team meetings
Pest Manager	<ul style="list-style-type: none"> Prepares, reviews, and revises the Pest Management Plan Manages the Integrated Pest Management Program
National Environmental Policy Act/ Environmental Impact Analysis Process Manager	<ul style="list-style-type: none"> Coordinates work requests, AF Form 813s, and environmental assessments with the installation natural resources manager to ensure appropriate natural resources information is captured in Federal undertakings
NOAA Fisheries	<ul style="list-style-type: none"> Reviews and coordinates on Section 7 and essential fish habitat consultations (formal and informal) related to effects on marine species at Fourth Cliff Recreation Area
United States Department of Agriculture, Forest Service	<ul style="list-style-type: none"> Coordinates on and, where applicable, issues permits for depredation Advises base etymologist on management of nuisance species
United States Fish and Wildlife Service	<ul style="list-style-type: none"> Assists with management of T&E species
MassWildlife	<ul style="list-style-type: none"> Provides updated species information to natural resource manager upon request Participates in the NEPA and MEPA review process for undertakings that may affect state protected species

2161 **5.0 TRAINING**

2162 USAF installation NRMs/Points of Contact and other natural resources support personnel require specific
 2163 education, training, and work experience to adequately perform their jobs. Section 107 of the Sikes Act
 2164 requires that professionally trained personnel perform the tasks necessary to update and carry out certain
 2165 actions required within this INRMP. Specific training and certification may be necessary to maintain a level
 2166 of competence in relevant areas as installation needs change, or to fulfill a permitting requirement.

2167 Installation Supplement—Training

- 2168 • NRMs at Category I installations must take the DoD Natural Resources Compliance course,
 2169 endorsed by the DoD Interservice Environmental Education Review Board, and offered for all
 2170 DoD Components by the Naval Civil Engineer Corps Officers School (CECOS). (See
 2171 <http://www.netc.navy.mil/centers/csfe/cecos/> for CECOS course schedules and registration
 2172 information.) Other applicable environmental management courses are offered by the Air Force
 2173 Institute of Technology (<http://www.afit.edu>), the National Conservation Training Center
 2174 managed by the USFWS (<http://www.training.fws.gov>), and the Bureau of Land Management
 2175 Training Center (<http://training.fws.gov>).
- 2176 • Natural resource management personnel shall be encouraged to attain professional registration,
 2177 certification, or licensing for their related fields, and may be allowed to attend appropriate
 2178 national, regional, and state conferences and training courses.
- 2179 • All individuals who will be enforcing fish, wildlife, and natural resources laws on USAF lands
 2180 must receive specialized, professional training on the enforcement of fish, wildlife, and natural
 2181 resource laws and regulations in compliance with the Sikes Act. This training may be obtained by
 2182 successfully completing the Land Management Police Training course at the Federal Law
 2183 Enforcement Training Center (<http://www.fletc.gov/>).
- 2184 • Individuals participating in the capture and handling of sick, injured, or nuisance wildlife should
 2185 receive appropriate training, including training that is mandatory for attaining any required
 2186 permits.
- 2187 • The DoD-supported publication, *Conserving Biodiversity on Military Lands—A Handbook for*
 2188 *Natural Resources Managers* (<http://dodbiodiversity.org>) provides guidance, case studies, and
 2189 other information regarding the management of natural resources on DoD installations.

2190 Natural resources management training is provided to ensure that installation personnel, contractors, and
 2191 visitors are aware of their roles in the program and the importance of their participation to its success.
 2192 Training records are maintained IAW [Section 6.0—Recordkeeping and Reporting](#) of this plan.

2193

2194 **6.0 RECORDKEEPING AND REPORTING**

2195 **6.1 *Recordkeeping***

2196 The installation maintains required records IAW AFI 33-322, *Records Management and Information*
2197 *Governance Program* (23 Mar 2020, Incorporating Change 1, 28 Jul 2021), and disposes of records IAW
2198 the Air Force Records Management System records disposition schedule. Numerous types of records must
2199 be maintained to support implementation of the natural resources program. Specific records are identified
2200 in applicable sections of this plan, in the Natural Resources Playbook, and in referenced documents.

2201 *Installation Supplement—Recordkeeping*

2202 Management of records is conducted in accordance with the EMS Records and Document Management
2203 Supplement which is reviewed and updated on an annual basis. In general, the Environmental Element
2204 maintains environmental records in a mix of hard copies located in Building 1825 and electronic copies
2205 maintained on the ERM Network Storage (V-drive). As the V-drive is restricted to only those personnel
2206 requiring records management permission, no link is provided on eDASH.

2207 **6.2 *Reporting***

2208 The installation NRM is responsible for responding to natural resources-related data calls and reporting
2209 requirements. The NRM and supporting Air Force Civil Engineer Center, Natural Resources Media
2210 Manager and Subject Matter Specialist should refer to the Environmental Reporting Playbook for guidance
2211 on execution of data gathering, quality control/quality assurance, and report development.

2212 *Installation Supplement—Reporting*

2213 The NRM incorporates the annual monitoring reports of nesting shorebirds at 4th Cliff into the annual
2214 INRMP implementation report, as well as all other INRMP work for the year and submits this report to the
2215 66 Civil Engineer Division lead and AFCEC support center. Additional reporting is accomplished on an
2216 as-needed basis as requests for project reviews are received from other HAFB departments.

2217

2218 **7.0 NATURAL RESOURCES PROGRAM MANAGEMENT**

2219 This section describes the current status of the installation’s natural resources management program and
 2220 program areas of interest. Current management practices, including common day-to-day management
 2221 practices and ongoing special initiatives, are described for each applicable program area used to manage
 2222 existing resources. Program elements in this outline that do not exist on the installation are identified as not
 2223 applicable and include a justification, as necessary.

2224 *Installation Supplement—Natural Resources Program Management*

2225 **7.1 Fish and Wildlife Management**

2226 *Applicability Statement*

2227 This section applies to all USAF installations that maintain an INRMP. The installation **IS** required to
 2228 implement this element.

2229 *Program Overview/Current Management Practices*

2230 Existing fish and wildlife inventories are included in this INRMP and will be updated as surveys are
 2231 completed over the next several years. General fish and wildlife management programs for HAFB and its
 2232 GSUs consists of (1) inventory species present, (2) map current locations of such species to determine high
 2233 quality habitats that support multiple species, (3) identify and eradicate invasive species, (4) incorporate
 2234 results into planning and environmental analysis for future projects to ensure continuation of the military
 2235 mission with minimal impact on fish and wildlife resources, (5) continue to monitor fish and wildlife
 2236 populations on a three–five year basis and adjust previous steps based on new information (such as changes
 2237 in abundance, species presence, mission requirements). By implementing an adaptive management strategy
 2238 for fish and wildlife resources, HAFB will ensure future changes to mission requirements will be
 2239 accommodated. Management techniques for T&E species and SSC will be discussed in more detail in
 2240 [Section 7.4](#).

2241 **Hanscom Air Force Base**

2242 The undeveloped forested uplands and wetlands at HAFB provide suitable breeding, foraging, and
 2243 sheltering habitat for several taxa, including avian, herptile, and mammalian species. The day-to-day
 2244 operations of current mission requirements have limited impacts on these undeveloped areas, and efforts to
 2245 manage them will have limited impacts on the military mission of HAFB. Current inventories and mapping
 2246 of fish and wildlife species will allow planners to consider impacts from new construction activities and
 2247 address methods to avoid, minimize, or mitigate those impacts.

2248 Hunting is not currently permitted on HAFB, and due to the developed nature of the installation, it is not
 2249 practical to develop a hunting program. Results of updated inventories will provide information for potential
 2250 fisheries management for the benefit of base personnel, if not a conflict with state-listed amphibian and
 2251 aquatic invertebrate conservation (see [Section 7.4](#)).

2252 HAFB implements an integrated Pest Management Plan (PMP) that controls populations of raccoons,
 2253 skunks, and opossums by securing food and trash-collection points (HAFB 2020c). Controlling the
 2254 abundance of these urban-adapted predators provides additional benefits to small mammals, herptiles, and
 2255 avian species by reducing predation pressure.

2256 **Fourth Cliff Recreation Annex**

2257 Shorebird species are known to nest and stage at 4th Cliff during annual migrations. USAF personnel
 2258 partner with Mass Audubon to annually survey shorebird species and breeding productivity at 4th Cliff;
 2259 these surveys are part of Mass Audubon’s Coastal Waterbird Program, which includes 177 sites and 125
 2260 miles of the Massachusetts coast (Mass Audubon 2019). Nesting areas of 4th Cliff are closed during the
 2261 breeding season to avoid disturbing shorebird species (HAFB 2017b). In partnership with the North and
 2262 South Rivers Watershed Association, 4th Cliff has initiated a blue mussel restoration project and will
 2263 continue to assist with this project when funding is available.

2264 **Sagamore Hill Solar Weather Observatory Annex**

2265 Habitat at Sagamore Hill is similar to undeveloped portions of HAFB but in a more rural location, which
 2266 provides greater habitat connectivity. The same management techniques for HAFB apply at Sagamore Hill
 2267 but with added emphasis on northern long-eared bat conservation (addressed in [Section 7.4](#)). Hunting and
 2268 fishing ~~is~~are not suitable at Sagamore Hill due to its small size and the presence of large military antennae
 2269 that could be damaged by stray bullets or arrows if hunting ~~was~~were allowed.

2270 *7.1.1 Climate Impacts on Fish and Wildlife Management*

2271 Fish and wildlife management at HAFB is not likely to be severely impacted by the projected changes in
 2272 climate. With the projected increases in temperature and slight increases in precipitation, wildlife
 2273 communities on the installation may alter their movements and timing of migration or breeding. Changing
 2274 climatic conditions may present opportunities for invasive species to flourish and push out native species,
 2275 so invasive species monitoring will be important and management plans should be flexible enough to adapt
 2276 to changing fish and wildlife concerns (Hellmann et al. 2008). Managers will need to conduct wildlife
 2277 surveys on a regular basis to document changes in native species populations.

2278 Prevention and control of wildlife disease spread will be critical to protect native species and habitats in a
 2279 changing climate. Increasing temperatures can favor disease-vectoring organisms such as mosquitoes and
 2280 ticks (Süss et al. 2008). Managers can reduce mosquito populations by minimizing stagnant water in and
 2281 around the cantonment area. Tick populations can be minimized in urban settings by keeping lawns mowed
 2282 and by preventing overabundances of hosts such as deer and rodents (Levi et al. 2012, Telford 2017).
 2283 Controlling small mammal and rodent populations could help curtail the potential of outbreaks.

2284 Continued application of the ecosystem-based management approach that maintains ecological processes
 2285 and habitat connectivity within the larger landscape would allow HAFB to be adaptable under changing
 2286 climate regimes. Important habitat locations, identified in terms of biodiversity, ecological
 2287 ~~processes~~processes, and habitat ~~connectivity~~connectivity, should be protected from adverse climate change
 2288 related disturbances. When practicable, future development activities should focus on already disturbed
 2289 areas or areas of lower-quality habitat.

2290 **7.2 Outdoor Recreation and Public Access to Natural Resources**

2291 *Applicability Statement*

2292 This section applies to all USAF installations that maintain an INRMP. The installation is required to
 2293 implement this element.

2294 *Program Overview/Current Management Practices*

2295 **Hanscom AFB**

2296 Outdoor recreation at HAFB entails passive use of outdoor areas for walking and biking. The base has a
2297 number of footpaths that are used primarily to access buildings by foot, but some paths travel through
2298 forested areas and can be used for scenic enjoyment. Additionally, HAFB has two picnic areas—Castle
2299 Park and Memorial Park—that consist of covered pavilions with benches and barbecuing grills, surrounding
2300 parks, volleyball pits, and playgrounds ([Figure 7-1](#)). FamCamp, which is located across Hanscom Field
2301 north of the main base, is an exclusive RV campsite open to all eligible military and DoD personnel.
2302 FamCamp includes 73 RV sites; 56 full-hookup sites with water, sewer, and electric; 17 partial-hookup
2303 sites with water and electric; and 10 tent sites. There are two separate bathhouses, a coin-operated laundry
2304 facility, an outdoor pavilion, and walking trails. FamCamp provides base personnel with an opportunity to
2305 enjoy passive outdoor recreation in a forested environment and the grasslands adjacent to Hanscom Field.

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2306

2307 Figure 7-1. Outdoor recreation facilities at Hanscom Air Force Base.

2308 All facilities at HAFB and FamCamp are restricted to military personnel and eligible DoD common access
 2309 cardholders due to security requirements, mission objectives, and relatively low recreation opportunities
 2310 for the general public. Hunting opportunities are not available due to the developed nature of the base and
 2311 close proximity of occupied buildings adjacent to all wildlife habitat areas. Currently, there is no fishing
 2312 program at HAFB; areas suitable for future fishing opportunities should be identified after surveys for T&E
 2313 species and SSC have been completed to avoid conflicts with protected species management. Finally,
 2314 although the Department of Veterans Affairs owns the Patriot Golf Course, HAFB maintains and operates
 2315 the golf course. The Patriot Golf Course, located off base in the town of Bedford on the Edith Nourse
 2316 Veterans Administration Hospital Campus, consists of a ~~nine-hole~~nine-hole course, pro-shop, driving range,
 2317 and tournament tent that are open to the public and military personnel, with a seasonal closure in winter.

2318 **Fourth Cliff Recreation Area**

2319 Recreation is the primary use of 4th Cliff. It provides cottages for rent, RV sites with electrical hookups,
 2320 and tent camping sites. The site also provides access to passive enjoyment of the outdoors in a coastal
 2321 setting, with access to beaches for walking, wildlife watching, swimming, and saltwater fishing. It is open
 2322 year-round with access restricted to military personnel and eligible DoD common access cardholders only
 2323 due to the current use levels of military personnel and lack of additional facilities to accommodate the
 2324 general public. The erosion at 4th Cliff prevents HAFB from developing additional parking and facilities
 2325 to accommodate public access. There are no hunting opportunities at 4th Cliff due to its small size and close
 2326 proximity to occupied buildings. Saltwater fishing is available along the coastline when in possession of a
 2327 current Massachusetts recreational fishing license. There are opportunities for watching wildlife,
 2328 particularly birds and the occasional marine mammal, from the elevated position of 4th Cliff; areas of the
 2329 barrier beach on the western portion are closed during the breeding season to protect nesting shorebirds;
 2330 however, guests are able to view the birds with binoculars from the elevated areas. Recreational off-roading
 2331 is not permitted on 4th Cliff ~~due to~~due to shorebird protection and the small area of beach available.

2332 **Sagamore Hill**

2333 Sagamore Hill does not contain any areas suitable for outdoor recreation or public access because of its
 2334 small size and the need to protect the military antennas on site.

2335 *7.2.1 Climate Impacts to Outdoor Recreation*

2336 The projected changes are not likely to prevent use of the golf course or other passive outdoor recreation
 2337 opportunities at HAFB such as walking, biking, picnicking, and camping. Projected changes in climate may
 2338 affect water and grounds management at the Patriot Golf Course.

2339 Increases in storm surges and sea level rise will likely increase the rate of erosion along the edge of 4th
 2340 Cliff, resulting in a loss of beaches and recreational opportunities. Coastal erosion has historically been a
 2341 significant problem, with the northeastern edge of the installation losing up to one linear foot per year.
 2342 Recent storm surges have increased the rate of erosion, with storms in 2016 and 2018 causing an additional
 2343 10 feet of erosion, resulting in the collapse of the nearby road and destruction of subsurface utilities. This
 2344 collapse resulted in loss of access to some camping opportunities (USAF 2019). If erosion continues to
 2345 encroach on the upper section of 4th Cliff, the existing buildings and rental areas located on the edges of
 2346 the property may need to be removed, further limiting recreational opportunities and the number of
 2347 available visitor spaces.

2348 Sea level rise and an increase in storm surges may also threaten the portion of the installation that is used
 2349 for nesting by piping plovers and least terns throughout the summer, which could affect areas used for
 2350 recreation. If habitat is lost, additional management may be necessary to maintain the remaining habitat,

2351 and areas currently available for recreation may be limited to reduce conflicts with these nesting species.
 2352 Additionally, the nearby nesting habitat provides a unique opportunity for birdwatching and passive
 2353 enjoyment of wildlife, and this could be lost altogether if the area becomes unsuitable for nesting.
 2354 Opportunities for outdoor recreation will continue to be offered at 4th Cliff, but coastal erosion mitigation
 2355 work will be required to ensure continued availability of several buildings and camping spaces.

2356 **7.3 Conservation Law Enforcement**

2357 *Applicability Statement*

2358 This section **IS NOT** applicable to HAFB and the GSUs.

2359 *Program Overview/Current Management Practices*

2360 HAFB does not maintain an installation-specific conservation law enforcement officer as the installation is
 2361 not large enough, and does not have enough conservation law enforcement violations to necessitate one.
 2362 HAFB focuses on education and outreach to base personnel and contractors about ~~existing~~existing
 2363 conservation standards. The installation and GSUs are fully ~~fenced~~fenced, and the main base is staffed with
 2364 security guards to limit unauthorized entry; these factors, combined with a lack of suitable areas for hunting
 2365 prevent the need for a designated conservation law enforcement officer.

2366 **7.4 Management of Threatened and Endangered Species, Species of Concern, and Habitats**

2367 *Applicability Statement*

2368 This section applies to USAF installations that have threatened and endangered species on USAF property.
 2369 This section **IS** applicable to this installation.

2370 *Program Overview/Current Management Practices*

2371 AFMAN 32-7003 3.38 requires HAFB to conserve and protect federally listed plants and animals and their
 2372 habitats, and to use the respective authority to conserve them. Similarly, Section 3.38.2 requires HAFB to
 2373 provide for the protection and conservation of state-listed protected species when practicable and consistent
 2374 with military missions.

2375 HAFB will use the USFWS Information for Planning and Consultation (IPaC) tool to determine all actions
 2376 which are required of HAFB to ensure compliance with the USESA. HAFB works with MassWildlife to
 2377 remain in compliance with state regulations and transfers data to MassWildlife/NHESP via Heritage Hub
 2378 annually or upon request.

2379 **7.4.1 Plants**

2380 There are no known T&E plant species or plant SSC at HAFB, but inventory surveys for all species have
 2381 yet to be completed. There are 259 plant species listed by the state of Massachusetts, three of which are
 2382 federally endangered and one of which is federally threatened (Table 14-8 within Appendix B). Of these,
 2383 the ~~federally threatened~~federally threatened small-whorled pogonia (*Isotria medeoloides*) could occur at
 2384 Sagamore Hill.

2385 CEMML (2022b) identified potential habitat for small-whorled pogonia in the southeastern portion of
 2386 Sagamore Hill. This area includes sunny gaps in the forest canopy with sparse ground cover, and includes
 2387 tree species that support ectomycorrhizal fungi associated with small-whorled pogonia. Surveys in 2021
 2388 and 2022 did not detect any form of small-whorled pogonia. ~~However, Although~~ the timeframe within
 2389 which those surveys were conducted was not consistent with USFWS guidelines, it was determined to be

an appropriate survey window based on the site phenology by the surveyor. ~~Additionally, the unpredictable and sometimes lengthy dormancy periods which this plant exhibits (USFWS 1992) make periodic surveys over time especially necessary. Therefore, surveys which are conducted on a periodic and ongoing basis, and which follow USFWS protocols, are necessary for determining presence of the species. as potential habitat is present, it is recommended that HAFB continues to periodically survey this portion of Sagamore Hill as mission requirements and funding allows. The unpredictable and sometimes lengthy periods of dormancy the plant exhibits (USFWS 1992) make periodic surveys over time especially important.~~

7.4.2 Invertebrates

The first step in managing federally- and state-protected invertebrate species at HAFB, Sagamore Hill, and 4th Cliff is to conduct invertebrate surveys. It is important to know which protected species occur on the installation so that proper conservation measures can be implemented. Dragonflies, butterflies, and moths account for the bulk of state-protected invertebrate species in Massachusetts, so future surveys should focus on these taxa.

The monarch butterfly is one of two invertebrate species with federal status that could potentially be found on the main base, Sagamore Hill, and/or 4th Cliff. The installation could support this species by establishing pollinator gardens that include milkweed, upon which monarch larvae feed exclusively (Flockhart et al. 2015). Common milkweed (*Asclepias syriaca*), swamp milkweed (*A. incarnata*), butterflyweed (*A. tuberosa*), ~~whorled milkweed (*A. verticillata*),~~ and poke milkweed (*A. exaltata*) are all native to Massachusetts (Steinmetz 2012), thus they are appropriate for planting at the main base, Sagamore Hill, and 4th Cliff. ~~Whorled milkweed is listed as threatened under MESA, which limits seed collection. However, a R~~restoration efforts developed with NHESP would support both, monarch conservation and ~~whorled~~ milkweed conservation. ~~Though they are milkweed pollinators, a~~Adult monarch butterflies also consume nectar from a variety of ~~other~~ flowers ~~and are not the efficient pollinators of milkweed~~ (MacIvor et al. 2017). ~~Therefore,~~ monarch habitat must also include a diversity of flowering plants, ensuring more self-sustainability in milkweed patches. Other state-listed pollinators, including the yellow-banded bumble bee, moths, butterflies, and other bee species will benefit from any conservation actions proposed for the monarch butterfly.

The Monarch Joint Venture is a partnership of federal and state agencies, businesses, and academic programs with the goal of protecting monarchs across the nation. They provide a framework for monarch monitoring and habitat restoration, which could be adopted at HAFB, Sagamore Hill, and 4th Cliff. Creation of a ~~community citizen~~ science monitoring program for the monarch butterfly would be an excellent way to engage ~~the surrounding~~ communities and collect data at low cost. The USAF *Pollinator Conservation Reference Guide* provides extensive resources and outlines plans for managing pollinators (USFWS 2017); Section 1.B.2 of the guide outlines the process for addressing T&E pollinators. ~~Finally, the USFWS is available for further technical assistance and guidance regarding the management of pollinator gardens.~~

Surveys to confirm whether intricate fairy shrimp are present are required at HAFB. To confirm whether adult intricate fairy shrimp are present, suitable vernal pool habitat should be surveyed early in the spring before water temperatures exceed 50 °F. Intricate fairy shrimp benefits from wetland protections in place at HAFB and project reviews within 100 feet of wetlands will consider the impact on wetlands inhabited by intricate fairy shrimp, and restricting herbicide and pesticide use within 100 feet of wetlands will help to maintain suitable water quality. Any future recreational fish program will exclude fish stocking in vernal pools inhabited by intricate fairy shrimp, but constraints on a recreational fishing program would be minimal because the ephemeral nature of vernal pools makes them unsuitable for fish stocking.

2433 Until surveys determine which state-listed invertebrates are present at HAFB, Sagamore Hill, and 4th Cliff,
 2434 a holistic approach to land management should be taken, with a focus on general needs of a broad array of
 2435 taxa. Listed below are some action plans and the taxa most likely to benefit from them.

- 2436 • Coordinate with the Integrated Pest Management team to further reduce the use of chemicals,
 2437 particularly pesticides, herbicides, and fungicides, which would benefit all invertebrates (Beketov
 2438 et al. 2013) and the predators that consume them, such as dragonflies, spiders, bats, birds, and
 2439 rodents.
- 2440 • Increase abundances of flowering plants on a landscape scale, with emphasis on spring-flowering
 2441 plants, but also including plants that flower throughout summer and fall. This would be
 2442 particularly beneficial to bumble bees, including the state-listed and federal-candidate species, the
 2443 yellow-banded bumble bee (Carvel et al. 2017).
- 2444 • Protect water sources from pollution (Moore 1997), invasive aquatic plants or algae, and rising
 2445 temperatures due to climate change (Poff et al. 2002) to protect dragonflies, damselflies, shrimp,
 2446 and other aquatic invertebrates.
- 2447 • Work with grounds maintenance to prevent mowing to protect butterfly and moth larvae from
 2448 being destroyed by lawn mowers. In areas where mowing must occur, ensure a mower height of
 2449 no less than four–six inches to preserve larvae nesting on or near the ground and/or restrict
 2450 mowing to once a year during the fall to help to preserve butterfly and moth larvae, as well as
 2451 general overwintering habitat for invertebrates (Massachusetts Butterfly Club 2010).
- 2452 • Reduce the use of nitrogen fertilizers to allow more diverse plant communities to thrive, which
 2453 would lead to a higher proportion of specialized insects (Schwägerl 2016).
- 2454 • Support a diverse array of plants (e.g., flowers, shrubs, trees, grasses, etc.) rather than
 2455 monocultures (e.g., lawns) to create more natural habitat where insects can reproduce (Schwägerl,
 2456 2016).

2457 *7.4.3 Vertebrates*

2458 **Hanscom Air Force Base**

2459 ***Bats***

2460 Northern long-eared bat was not confirmed during manual review of acoustic recordings collected at HAFB
 2461 in 2017; however, because their calls were auto-classified only during software review, Schwab (2018)
 2462 suggests that northern long-eared bat cannot be confirmed as absent (see [Section 2.3.4](#)). Therefore, bat
 2463 surveys will continue every three–five years, as funding allows, by using [current USFWS survey](#)
 2464 [guidelines for acoustic recordings or mist-netting methods. If protected species are detected \(in addition to](#)
 2465 [those already detected in previous surveys\), the installation will follow the DoD Legacy Program \(2019\)](#)
 2466 [BMPs for the respective species. If USESA listed species are detected, HAFB will also consult with the](#)
 2467 [USFWS to determine further management actions.](#) As of 2021, all bat species in the area listed under the
 2468 USESA or MESA have similar life histories and ecological requirements, including little brown bat,
 2469 northern long-eared bat, eastern small-footed bat, and tricolored bat. Therefore, an ecosystem-based
 2470 management strategy will be employed to conserve all listed bat species. Management techniques for bat
 2471 species are listed below.

- 2472 • Conduct surveys [according to current USFWS survey guidelines](#) to detect bat species present at
 2473 HAFB and the GSUs every three–five years, as funding allows.
- 2474 • When surveys confirm the presence of a listed bat species, HAFB will notify USFWS (for
 2475 northern long-eared bat) and NHESP.

- 2476 • From 01 June to 31 July each year, HAFB will prohibit tree removal in confirmed forest habitat,
2477 except when there are safety concerns or it would compromise the military mission, as permitted
2478 by the northern long-eared bat 4(d) rule (USFWS 2016).
- 2479 • Survey the HAFB and the GSUs for ~~any possible~~ hibernacula.
- 2480 • The USAF reviews all projects ~~to~~ that occur within wetlands and will consider potential impacts
2481 on listed bats and invertebrate prey sources. To prevent impacts to invertebrate prey species,
2482 pesticide use will be excluded from these areas, with the exception for maintaining existing
2483 landscaping.
- 2484 • Prior to any construction work on existing buildings at HAFB, surveys will be conducted to
2485 ensure that no listed bat species are present. If listed bat species are discovered, they will be
2486 removed to suitable forested habitat prior to construction work.

2487 ***Grassland birds***

2488 Upland sandpipers, grasshopper sparrows, and eastern meadowlark are known to use grassland habitat at
2489 the adjacent Hanscom Field. Massport manages the habitat in a way that benefits these three species and
2490 reduces BASH concerns. Grasslands in Massachusetts are disturbance-dependent to preclude successional
2491 stages that replace grasslands with shrubs and trees (MassWildlife 2015a). Currently, the largest native
2492 grassland habitats that support breeding populations of grassland obligate songbirds on mainland
2493 Massachusetts are located on military installations and airports (MassWildlife 2015a). Massport is
2494 responsible for the management of grassland habitat outside of the HAFB boundary.

2495 ***Reptiles***

2496 eDNA surveys conducted in 2021 for Blanding’s and wood turtle did not detect either species at HAFB or
2497 Sagamore Hill. Continuing eDNA surveys on a three- ~~to five year~~ five-year basis will provide additional
2498 support for whether these species are present or absent from HAFB. If any positive eDNA detections are
2499 made, localized species-specific surveys will be conducted to determine whether that species is present and
2500 breeding on HAFB, or travelling through to adjacent habitat patches. Until protected turtle species are
2501 confirmed, HAFB will consult with NHESP and USFWS about projects with potential impacts to listed
2502 reptiles. If the Blanding’s turtle or the wood turtle are detected, the installation will follow the DoD Legacy
2503 Program (2019) BMPs. If listed species are detected, HAFB will consult with the USFWS to determine
2504 proper management actions.

2505 Additional management techniques that may be implemented if protected turtle species are identified in the
2506 future are listed below (PARC 2019).

- 2507 • Avoid the removal of natural vegetation in riparian and wetland areas.
- 2508 • Maintain natural structures within stream channels to provide basking and sheltering locations.
2509 Avoid using riprap, as it precludes turtle movements.
- 2510 • Provide base personnel with fact sheets on reptiles, informing them that collecting wild turtles is
2511 prohibited on the installation, and that pets must be leashed around riparian and wetland areas.
- 2512 • Place turtle crossing signs in areas where turtles cross roads to reach nesting habitat to reduce
2513 road mortality. In areas with high rates of road mortality, consider implementing culverts to
2514 facilitate turtles crossing underneath the road, when funding is available.
- 2515 • Limit use of fertilizer and herbicide to existing landscaped areas and only apply the minimum
2516 amount necessary.

- 2517 • Limit use of road salt near wetlands.
- 2518 • When construction activities have the potential to release sediment, use hay bales or woodchips to
- 2519 preclude sediment transport into wetlands and streams. Place any uncontaminated dredge spoil
- 2520 with high sand content in areas that facilitate turtle breeding.
- 2521 • Continue to implement the integrated PMP to control predator populations. Trapping programs
- 2522 will be considered if predator numbers increase.
- 2523 • Consider implementing methods to decontaminate equipment such as decontaminating
- 2524 shoes/vehicles/grounds maintenance equipment when accessing wetlands to avoid transferring
- 2525 invasive species, or diseases to which reptiles are susceptible, such as Ranavirus
- 2526 (family *Iridoviridae*).

2527 ***Blue-Spotted Salamander***

2528 Blue-spotted salamander eggs were documented at HAFB in 2022, confirming that this species breeds on
 2529 the installation. Ongoing blue-spotted salamander surveys will be conducted on a three- to five-year basis
 2530 as funding allows to determine trends in populations over time, and to determine whether the HAFB consists
 2531 of genetically pure individuals, or unisexual hybrids (i.e., blue-spotted salamander x Jefferson salamander).
 2532 The latter is most likely given the larger distribution of this form. The two types can be differentiated in the
 2533 field, with unisexual individuals being larger with a gray-brown coloration versus genetically pure
 2534 individuals being smaller and jet-black. Unisexual female hybrids are still able to reproduce successfully
 2535 with genetically pure male individuals, most frequently producing exclusively unisexual hybrid offspring.
 2536 Therefore, additional efforts may be made to protect genetically pure populations if they are detected.

2537 Wetlands which are confirmed to host blue spotted salamanders on HAFB will be considered for upland
 2538 habitat protection by establishing protection buffers surrounding the site(s). This protection buffer will
 2539 prohibit ground disturbances and mission use, and the buffer radius will be determined in coordination with
 2540 MassWildlife.

2541 Ecosystem-based management techniques for wetlands will also benefit the blue-spotted salamander,
 2542 specifically those listed below.

- 2543 • Avoid the removal of natural vegetation in riparian and wetland areas.
- 2544 • Provide base personnel with fact sheets on amphibians, informing them that pets must be leashed
- 2545 around wetland areas, which will prevent pet predation on small mammals that create burrows
- 2546 used by overwintering blue-spotted salamander.
- 2547 • Limit fertilizer and herbicide use to existing landscaped areas, and only apply the minimum
- 2548 amount necessary.
- 2549 • Limit use of road salt near wetlands.
- 2550 • When construction activities have the potential to release sediment, use hay bales or woodchips to
- 2551 prevent sediment transport into wetlands and streams. Avoid soil compaction around wetlands to
- 2552 ensure that small mammals can still burrow into the soil, as blue-spotted salamander use these
- 2553 burrows for over-wintering.
- 2554 • Implement the integrated PMP to control predator populations. Trapping programs will be
- 2555 considered if predator numbers increase, as they reduce small mammal populations, and blue-
- 2556 spotted salamander require small mammal burrows for overwintering.
- 2557 • Consider implementing methods to decontaminate equipment to avoid transferring invasive
- 2558 species, or diseases to which amphibians are susceptible, such as chytrid fungal infections.

2559 ***Bridle Shiner***

2560 Determining whether bridle shiners are present at HAFB is the first step to their management. The
 2561 Shawsheen River may provide suitable slow-moving, open water habitat and should be surveyed to
 2562 document the fish species present. If bridle shiners are confirmed, several management techniques currently
 2563 employed to protect the river water quality will enhance bridle shiner conservation. Aquatic vegetation will
 2564 also be surveyed, and any invasive species, particularly those that reduce areas of open water, will be
 2565 eradicated to maintain suitable bridle shiner habitat (NHESP 2015b). Finally, restricting use of herbicides,
 2566 pesticides, and road salt within 200 feet of the Shawsheen River will help to maintain suitable water quality.

2567 **Fourth Cliff Recreation Annex**

2568 ***Bats***

2569 Suitable habitat for listed bat species is sparse at 4th Cliff, although there are some small patches of mature
 2570 deciduous trees that the bats could use for summer roosting. In 2017, however, little brown bat and
 2571 tricolored bat were confirmed during the acoustic surveys (Schwab 2018), and it is likely that 4th Cliff is
 2572 used by bats primarily for foraging and supports a small number of roosting bats. As of 2022, all bat species
 2573 listed under the USESA or MESA and known to occur in the area have similar life histories and ecological
 2574 requirements; therefore, an ecosystem-based management strategy will be employed to conserve all listed
 2575 bat species, including forested roosting habitat, and invertebrate prey sources. Management techniques for
 2576 bat species include habitat protection and routine surveys to determine species present (detailed above) and
 2577 surveys to determine whether there any bat hibernacula at 4th Cliff. All 3–5-year surveys are conducted
 2578 using the current USFWS survey guidelines.

2579 ***Shorebirds***

2580 Hanscom AFB will continue to consult with NOAA for Essential Fish Habitat, and work with Mass
 2581 Audubon to annually survey breeding and staging shorebirds at 4th Cliff, when funding allows. HAFB ~~also~~
 2582 will also implement the following management techniques (Iglecia and Winn 2021).

- 2583 • Shorebird nesting areas will be closed in accordance with MassWildlife guidelines. ~~to~~
 2584 recreational activities and closure aAreas will be closed to recreation, marked with multiple signs,
 2585 and roped-off between the signs to clearly delineate closed areas. Adding rope between signs
 2586 helps to clearly identify the areas closed and leads to greater compliance rates.
- 2587 • 4th Cliff visitors will be informed about the presence of ~~federally-listed~~federally listed shorebirds,
 2588 where seasonal closures are, and that they are required to keep pets inside or leashed to prevent
 2589 disturbance to shorebirds.
- 2590 • Implementation of the HAFB integrated PMP will continue to prevent populations of raccoons,
 2591 skunks, and opossum from accessing subsidized food sources, artificially inflating their numbers.
 2592 Trapping these predators may be conducted if needed to reduce predation on shorebirds. Predator
 2593 control methods will adhere to the proper legislation, permits, and/or contracts as projects are
 2594 developed.
- 2595 • When funding allows, HAFB will work with the North and South Rivers Watershed Association
 2596 to restore blue mussels in the New Inlet estuary to benefit shorebirds, particularly red knots.

2597 ***Eastern Box Turtle***

2598 Surveys are needed to confirm presence of eastern box turtle at 4th Cliff. Habitat is limited to small patches
 2599 of deciduous trees, and the only water at and surrounding 4th Cliff are brackish or saltwater. The eastern
 2600 box turtle is ~~a more~~more terrestrial than other turtle species in Massachusetts; but the 4th Cliff habitat

2601 characteristics make it unlikely to support a large eastern box turtle population. If eastern box turtles are
 2602 confirmed at 4th Cliff, their locations will be marked, and a habitat assessment will be conducted to
 2603 determine limiting factors. Management techniques for eastern box turtle are listed below.

- 2604 • Install turtle-crossing signs on roads adjacent to known locations of eastern box turtle occurrence,
 2605 as long as the signs do not encourage visitors to collect turtles.
- 2606 • Inform 4th Cliff visitors about the presence of the state protected eastern box turtle and that
 2607 collections of eastern box turtle are ~~prohibited~~prohibited, and pets must be leashed.
- 2608 • The integrated PMP will be implemented to reduce the populations of predatory raccoons,
 2609 skunks, and opossums.

2610 ***Protected Marine Species***

2611 NOAA Fisheries has identified the waters surrounding 4th Cliff as being suitable for several protected
 2612 marine species that use these waters for feeding and migration. Routine use of 4th Cliff has limited potential
 2613 to impact these species; however, construction projects that require access from the water have the potential
 2614 to impact them. Consultation with NOAA Fisheries will occur on an as-needed basis and general
 2615 management recommendations are provided below to mitigate impacts to marine species (HAFB 2019c).

- 2616 • Shallow-draft vessels will be used to maximize the clearance between the vessel and the river
 2617 bottom.
- 2618 • When in areas where whales or marine turtles are expected, vessel speeds will not exceed 10
 2619 knots.
- 2620 • Observers will be present on vessels to identify whales and marine turtles; they will take action to
 2621 avoid collisions when protected species are sighted. These sightings will be reported to NOAA
 2622 Fisheries within 24 hours.

2623 **Sagamore Hill Solar Weather Observatory Annex**

2624 ***Bats***

2625 As of 2022, all bat species in the area that are listed under the USESA or MESA have similar life histories
 2626 and ecological requirements (this includes little brown bat, northern long-eared bat, and tricolored bat, all
 2627 of which were confirmed at Sagamore Hill in 2017; Schwab 2018); ~~therefore~~therefore, an ecosystem-based
 2628 management strategy will be employed to conserve all listed bat species, their habitat, and their prey
 2629 sources. Specific management techniques for bat species include habitat protection and conducting routine
 2630 surveys (detailed above) and surveys to determine whether there are any suitable bat hibernacula at
 2631 Sagamore Hill. All 3–5-year surveys are conducted using the current USFWS survey guidelines.

2632 ***Golden-Winged Warblers***

2633 Surveys are needed to confirm the presence of golden-winged warbler on Sagamore Hill. Surveys also
 2634 should confirm whether blue-winged warblers or golden-winged warbler × blue-winged warbler hybrids
 2635 are present. Although there is limited second-growth habitat favored by golden-winged warbler at
 2636 Sagamore Hill, suitable habitat is frequently found in utility easements, the vegetation of which is kept at
 2637 earlier levels of succession to protect power lines. Creating suitable habitat for golden-winged warbler,
 2638 however, may impact forested roosting areas used listed bat species and therefore will not be considered
 2639 without consulting USFWS and NHESP. A habitat management plan that maintains a mosaic of patches,
 2640 including open areas for foraging bats, ~~second-growth~~second growth for golden-winged warbler, and
 2641 established forest for listed bats may be a potential solution. Due to Sagamore Hill’s small size, however,

2642 a landscape approach with neighboring landowners and entities would be required to implement a mosaic
2643 of sufficiently sized habitat patches.

2644 ***Blanding's Turtle***

2645 eDNA surveys conducted in 2021 did not detect Blanding's turtle at Sagamore Hill (CEMML 2022b).
2646 Ongoing eDNA surveys provide a cost-effective method to routinely monitor for this species on a three-~~to~~
2647 ~~five-year~~five-year basis, as funding allows. Until evidence of Blanding's turtle presence at Sagamore Hill,
2648 the USAF will consult with NHESP and USFWS about such projects. Additional management techniques
2649 to be implemented in areas of known turtle occupancy are detailed in the HAFB section above.

2650 ***Blue-Spotted Salamander***

2651 CEMML (2022b) detected weakly positive blue-spotted salamander eDNA in samples collected from
2652 Sagamore Hill and blue-spotted salamanders were last observed at Sagamore Hill in 1996 (MassWildlife
2653 2021). Due to resource constraints, additional follow-up surveys were not conducted in 2022 and Sagamore
2654 Hill will be surveyed for blue-spotted salamanders using funnel trap or cover object survey methods in the
2655 future. If ~~the~~ blue-spotted salamander ~~are~~is documented, it will be determined whether populations consist
2656 of genetically pure individuals, unisexual hybrids individuals, or a mix of the two. Individuals can be
2657 differentiated in the field because the unisexual hybrids are larger and gray-brown, whereas the genetically
2658 pure individuals are smaller and jet-black. Additional effort will be made to protect genetically pure
2659 populations. Ecosystem-based management techniques for wetlands will benefit blue-spotted salamander
2660 as detailed in the HAFB section above.

2661 *7.4.4 Climate Impacts on Threatened and Endangered Species Management*

2662 Of the species CEMML (2022a) assessed for HAFB, the monarch butterfly, piping plover, northern long-
2663 eared bat, tricolored bat, and little brown bat are highly vulnerable to the projected changes in climate; all
2664 other species showed moderate or low vulnerability. Monarch butterflies and other important pollinators
2665 that have experienced recent population declines are projected to be vulnerable to climate change, especially
2666 to changes in the timing of plant flowering, severe storms, and droughts. Monitoring of monarch butterflies,
2667 their milkweed host plants, and other important pollinators should be a high priority for the installation.
2668 Monitoring of piping plovers at 4th Cliff, especially during nesting season, should also be a priority. Three
2669 of the four bat species CEMML assessed are facing multiple threats to their populations, which are expected
2670 to decline further due to white-nose syndrome and climate-related impacts. Maintaining healthy bat
2671 populations depends on good stewardship of the forests and maintenance of normal disturbance patterns
2672 through timber management and selective harvesting. In general, management actions needed to protect
2673 these species will be influenced by the speed at which the climate changes, the nature of the climatic
2674 changes, and the ability of the species to adapt. Ongoing monitoring will allow managers to determine
2675 species' responses to climate change, and whether management objectives are ~~effective~~effective, or
2676 adjustments are required.

2677 Climate adaptation (i.e., making changes to natural or human systems that minimize the impacts or promote
2678 the benefits of climate change) will be an important management tool for protecting T&E species from the
2679 most severe climate change impacts. However, ~~single-specie~~single species approaches to climate
2680 adaptation run the risk of interrupting ecosystem function and further imperiling other species. DoDI
2681 4715.03 advises installations to instead employ adaptive and ecosystem-based management. As such, many
2682 current T&E management activities are appropriate for increasing resilience or facilitating adaptation to
2683 climate change. For example, an ecosystem approach that prioritizes habitat maintenance, habitat
2684 variability, and habitat connectivity can help support genetic and functional diversity. In turn, genetic and

2685 functional diversity can facilitate adaptation and help species migrate to favorable habitats. As temperatures
2686 increase, it will be increasingly important to plant or retain more drought-tolerant plant species.

2687 However, given the uncertainty inherent in managing species under changing environmental conditions,
2688 additional analysis and planning is required. Research into actionable science used for biodiversity
2689 conservation in changing conditions has demonstrated that historic patterns used for management decisions
2690 are likely to be insufficient for future management challenges (Bierbaum et al. 2013). Instead, proactive
2691 approaches that anticipate change can help extend the period over which species can adapt to a changing
2692 climate and avoid catastrophic declines associated with stochastic events that act on an already stressed
2693 ecosystem.

2694 Effective approaches to climate adaptation require site-specific climate projections as well as local
2695 knowledge of species and their habitats. Adaptation actions can focus on addressing changes as they occur
2696 (i.e., reactive strategies) or can seek to avoid impacts of changes (i.e., proactive strategies). In the context
2697 of T&E species with limited habitats, it may be prudent to focus on proactive strategies to avoid losses that
2698 may hinder species recovery. However, if changes in the environment are already affecting priority species,
2699 a reactive approach could still improve long-term species survival. Managers can further refine actions,
2700 whether proactive or reactive, by considering how they intend to manage change in the system. Resistance
2701 strategies seek to maintain the status quo and prevent change from affecting the species. Resilience
2702 strategies support ecosystem function without fundamental change. Realignment strategies focus on
2703 understanding that some changes will occur, and support transitioning to a new ecosystem state (Holling
2704 1973, Millar et al. 2007).

2705 Most depictions of the adaptive management cycle include phases for planning, acting, and evaluating.
2706 Managers should explicitly address T&E species and their specific vulnerabilities to a changing climate at
2707 several stages of the adaptive management cycle. For guidance on the adaptive management process, a
2708 comprehensive guide has been developed to assist DoD installations (Stein et al. 2019) and can be used to
2709 identify and address climate-related threats to species of concern and their habitats. Furthermore, scenario
2710 planning and scenario-based assessment models have emerged to help decision makers take proactive
2711 management actions despite uncertainty (Banuls and Salmeron 2007).

2712 **7.5 Water Resource Protection**

2713 *Applicability Statement*

2714 This section applies to USAF installations that have water resources. This section **IS** applicable to this
2715 installation.

2716 *Program Overview/Current Management Practices*

2717 **Hanscom Air Force Base**

2718 Segment MA83-08 of the Shawsheen River, located on part and just downstream of HAFB, is listed as
2719 impaired due to high levels of fecal coliform bacteria. For this segment of river, surface runoff from physical
2720 substrate habitat alterations and channeling are the main sources of fecal coliform, which may come from
2721 pets, livestock, and wildlife (Massachusetts Division of Watershed Management 2002; USEPA 2022). To
2722 help reduce the fecal coliform loads in this river segment, the base should implement best management
2723 practices, such as proper pet waste removal, street sweeping, and reductions of impervious surfaces where
2724 possible.

2725 Surface runoff at HAFB is regulated through a National Pollutant Discharge Elimination System permit
2726 issued by the USEPA. As a result, construction activities on the base are monitored in areas near wetlands.

2727 To help ensure that the base is not contributing pollutants, there is a base-wide program to monitor water
 2728 quality and determine whether pollutants are present.

2729 Under the National Pollutant Discharge Elimination System, the base is also required to promote outreach
 2730 and education about surface water. Outreach and education are provided to in-house maintenance personnel
 2731 (no residents) about how to properly collect and dispose of yard waste and other material and how to
 2732 properly apply fertilizer (USEPA 2020).

2733 A portion of the surface water that runs off HAFB eventually flows to Hobbs Brook Reservoir, which
 2734 supplies roughly 15 million gallons of water each day to 95,000 people in the City of Cambridge,
 2735 Massachusetts (United States Geological Survey 1998). To help manage and maintain this water supply,
 2736 the Cambridge Water Department has created an innovative Source Water Protection Plan that includes
 2737 monitoring streamflow and water quality in the drainage basin, tracking development and construction
 2738 activities, advocating for stormwater-management improvements, and maintaining a hazards-response
 2739 program.

2740 **Fourth Cliff Recreation Annex**

2741 The 4th Cliff site is located in a corridor protected by the Scenic and Recreational Protected River Order
 2742 for North River, which also covers marshes and a 300-foot-wide upland area on both sides of the River,
 2743 including land in the towns of Scituate, Marshfield, Norwell, Hanover, Hanson, and Pembroke. The order
 2744 aims at protecting public and private property, wildlife, fresh and saltwater fisheries, and irreplaceable wild,
 2745 scenic, and recreational river resources (North River Commission 2021). To preserve this valuable resource,
 2746 the regulation identifies the land subject to protection under this order and specifies the allowed, prohibited,
 2747 and special permit uses within the protected areas.

2748 A severe coastal storm in 2018 caused extensive damage at 4th Cliff, resulting in erosion of 10 feet from
 2749 cliff, collapse of the perimeter road, and severance of the underground utilities (Onderko 2019). Ongoing
 2750 erosion is also damaging the coastal bank, parking area, camping area, picnic area, stairway, and fencing.
 2751 As a result, addressing shoreline erosion is a necessity and efforts are ongoing.

2752 **Sagamore Hill Solar Weather Observatory Annex**

2753 ~~The Sagamore~~[Sagamore](#) Hill is part of the Ipswich River watershed. This watershed covers all or part of
 2754 21 communities that rely on the streams and aquifers of this watershed for drinking water (Mass.gov 2021).
 2755 This demand, along with land-use changes, creates low-flow conditions in sections of the Ipswich River,
 2756 causing water-quality issues and reducing groundwater recharge.

2757 Flow from Sagamore Hill runs to Nicholas Brook and then to the mouth of the Ipswich River. For
 2758 opportunities to help reduce water demand, water conservation methods, such weather-based irrigation
 2759 controllers, also should be considered.

2760 *7.5.1 Climate Impacts on Water Resource Protections*

2761 Climate change is expected to affect the condition of water resources due to the close connection between
 2762 climate and the hydrologic cycle. At HAFB, 4th Cliff, and Sagamore Hill, climate change likely will
 2763 increase the frequency and intensity of severe weather, inland and coastal flooding events (NE CASC 2018).

2764 In turn, this would lead to a cascade of effects, including an ~~increase~~[increase in](#) the amount of stormwater
 2765 runoff and its associated pollutants such as illness-causing bacteria and sediment entering watersheds.
 2766 Furthermore, climate change is likely cause longer and more frequent droughts, potentially making the
 2767 ground less conducive to stormwater infiltration and causing vegetation die-off, which would exacerbate
 2768 runoff velocity and expose soils directly to erosion. These changes would likely lead to influxes of organic

2769 matter and nutrients in aquatic ecosystems, resulting in eutrophication and other detrimental impacts
 2770 (MEMA and EOEAA 2018). Climate change further threatens aquatic ecosystems as rising CO₂ levels and
 2771 warming temperatures increase the likelihood of algal blooms (Paerl et al. 2011).

2772 **7.6 Wetland Protection**

2773 *Applicability Statement*

2774 This section applies to USAF installations that have existing wetlands on USAF property. This section **IS**
 2775 applicable to this installation.

2776 *Program Overview/Current Management Practices*

2777 Wetlands in Massachusetts are protected under the federal Clean Water Act, the Massachusetts Wetlands
 2778 Protection Act (MWPA), and local wetland bylaws. Often towns and cities have adopted local wetland
 2779 bylaws or ordinances that are more ~~stringent~~stringent than those in the Massachusetts Wetlands Protection
 2780 Act or the Clean Water Act. However, the purview of state regulations and local bylaws do not include
 2781 federal properties such as HAFB.

2782 ~~One~~exceptions to this are Sections 401 and 404 of the Clean Water Act. Sections 401 and 404 establish
 2783 the requirement of Section 404 applicants to obtain a state water quality certificate. Thus, HAFB is subject
 2784 to the terms and conditions of a Massachusetts state water quality certificate for any CWA Section 404
 2785 activities. As a federal agency, HAFB is also subject to EO 11990, *Protection of Wetlands*. Under EO
 2786 11990, HAFB is required to ‘minimize the destruction, ~~loss~~loss, or degradation of wetlands, and to preserve
 2787 and enhance the natural and beneficial values of wetlands’ that lie within installation boundaries.

2788 Compliance with applicable requirements helps to conserve wetlands and meet the no-net-loss wetlands-
 2789 protection standard. Management goals should include sustaining a water quality-monitoring program that
 2790 will identify pollutants and evaluate key parameters essential to a healthy ecosystem. To support wetland
 2791 plant and animal species, another management goal is to limit the encroachment of development into
 2792 existing wetland areas.

2793 **Hanscom Air Force Base**

2794 At HAFB, inland wetlands are found in the headwaters of the Shawsheen River ([Figure 2-8](#)). Each of the
 2795 towns that overlap HAFB (Bedford, Lexington, and Lincoln) has adopted local wetland bylaws and
 2796 regulations. Though lands at HAFB may not be subject to all local regulations or permitting, they are listed
 2797 here as a reference for developing and applying best management practices to wetland resources at HAFB.
 2798 HAFB will communicate with local towns regarding proposed mission activities that may impact wetlands.

2799 The Town of Bedford (through its Wetlands Protection Bylaw and Regulations) protects wetlands, related
 2800 water resources, adjoining land areas, and important wildlife areas (Town of Bedford 2016). Under this
 2801 Bylaw, no person shall remove, fill, dredge, discharge into, or otherwise alter areas within 100 feet of any
 2802 freshwater wetland, including any isolated vegetated wetland, marsh, wet meadow, bog, swamp, or vernal
 2803 pool.

2804 The Town of Lexington (in its Rules Adopted by the Lexington Conservation Commission Pursuant to the
 2805 town’s code for Wetland Protection, Chapter 130) (Town of Bedford 2016) considers any wetland or land
 2806 bordering the wetland to be a protected resource area (Lexington Conservation Commission 2014). If
 2807 wetlands are destroyed, they must be replaced at a 2:1 ratio to ensure no net loss of wetland area.

2808 The Town of Lincoln (in its Wetlands Protection Bylaw, Article XVIII) considers all wetland and upland
 2809 areas to be protected, whether or not they border surface waters (Town of Lincoln 2007). Lands within 100
 2810 feet of a wetland resource are protected by this bylaw. Based on the Bylaw and Regulations, a 50- to 100-
 2811 foot, undisturbed, vegetated setback extending perpendicularly from the wetland boundary is required.

2812 HAFB will internally review projects within these ~~locally defined~~ locally defined buffer zones as part of the
 2813 EIAP and adjust projects to best avoid wetland impacts on HAFB, when not in conflict with the military
 2814 mission.

2815 From a management perspective, a crucial first step in protecting these resources is to halt losses of existing
 2816 wetlands through alteration and development. If NRMs at HAFB choose to pursue freshwater wetland
 2817 restoration as an alternative to offset losses or increase wetland habitat, best management practices should
 2818 be adopted. An important consideration in restoration is to avoid the loss of microbial communities and soil
 2819 structure through disruption from heavy machinery and stockpiling. Instead, transplanting intact wetland
 2820 soil or vegetation in wetland restoration sites is more likely to lead to successful establishment of endemic
 2821 wetland species and reduce greenhouse gas emissions (Moomaw et al. 2018).

2822 **Fourth Cliff Recreation Annex**

2823 There are many coastal wetlands at 4th Cliff, and though local regulations and permitting may not apply to
 2824 wetlands management here, they are listed here as a reference for developing and applying best management
 2825 practices for the protection of wetland resources at 4th Cliff. The Town of Scituate (through its Code of
 2826 Bylaws, Section 30700, Wetlands Protection Rules and Regulations) considers any bank, cliff or bluff,
 2827 freshwater wetland, coastal wetland, beach, dune, flat, marsh, wet meadow, bog, or swamp a resource area
 2828 that must be protected (Scituate Conservation Commission 2016). This includes areas subject to tidal action
 2829 or which border the ocean, such as beaches, dunes, tidal flats, coastal banks, salt marshes, and salt meadows.
 2830 Also, any land within 100 feet of any resource area is considered a buffer zone by the Town of Scituate.
 2831 Any operator conducting an activity within these areas that could alter them is required to submit a Notice
 2832 of Intent to the Town of Scituate's Conservation Commission. Additionally, the Massachusetts Wetlands
 2833 Protection Act protects the ability of sand dunes and wetlands to migrate without human interference in the
 2834 hope that over time it will result in less loss or coastal resources (MEMA and EOEEA 2018). HAFB will
 2835 internally review projects within this ~~locally defined~~ locally defined buffer as part of the EIAP and adjust
 2836 projects to best avoid wetland impacts on 4th Cliff, when not in conflict with the military mission.

2837 **Sagamore Hill Solar Weather Observatory Annex**

2838 Wetlands also occur at Sagamore Hill along the northern boundary and bisecting the installation ([Figure](#)
 2839 [2-9](#)), and though local regulations and permitting may not apply to wetlands management here, they are
 2840 listed as a reference for developing and applying best management practices for the protection of wetland
 2841 resources at Sagamore Hill. The Town of Hamilton (through its Conservation By-Law, Chapter 17) also
 2842 considers land within 100 feet of a wetland as a buffer zone for wetland protection. All projects within this
 2843 buffer zone must submit a Notice of Intent to the Town of Hamilton Conservation Commission. HAFB will
 2844 internally review projects within this ~~locally defined~~ locally defined buffer as part of the EIAP and adjust
 2845 projects to best avoid wetland impacts on Sagamore Hill, when not in conflict with the military mission.

2846 *7.6.1 Climate Impacts on Wetland Protection*

2847 Wetland systems are vulnerable to changes in the quantity and quality of their water supply, and climate
 2848 change is expected to drive pronounced alterations in hydrological regimes (Erwin 2009). The increases in
 2849 average minimum, maximum, and average temperature projected with all emissions scenarios would likely
 2850 increase evapotranspiration. The projected increase in the number of days over 90°F in all scenarios will

2851 also increase evapotranspiration, potentially reducing wetland water levels, especially in the summer. The
 2852 extent of potential wetland loss at HAFB will depend on the balance of changes in precipitation versus
 2853 evapotranspiration, as well as the timing and magnitude of snowmelt. These changes could interfere with
 2854 the vital ecosystem services wetlands perform, such as storing carbon, improving water quality, providing
 2855 wildlife habitat, and contributing to biodiversity.

2856 The expansion of invasive plant species' ranges could also have negative impacts on the health of wetlands
 2857 at the installation (Junk et al. 2013). Invasive plant species tend to have broader environmental tolerance
 2858 limits, such as being more resilient to higher temperatures and altered hydrological regimes. Invasive
 2859 species (e.g., common buckthorn, common reed, and purple loosestrife) may outcompete native wetland
 2860 plants. Invasive species could alter plant community structure and diversity, plant productivity, nutrient
 2861 cycling, and soil biota in wetlands (Zedler and Kercher 2004). Future wetland management efforts could
 2862 reduce the impact of climate change in wetlands by preventing encroachment of these species.

2863 Coastal wetlands are threatened by climate change. Increasingly intense waves, higher tides, and stronger
 2864 currents from sea level rise and increasing storm surges erode beaches, dunes, and embankments, reducing
 2865 the buffer between the sea and coastal habitats. Coastal wetlands serve as powerful natural tools for
 2866 counteracting some effects of climate change. They provide a natural form of storm protection and erosion
 2867 reduction; thus, they are considered a cost-effective means of protecting coastal communities and
 2868 infrastructure (Moomaw et al. 2018).

2869 To preserve the salt marsh and coastal wetland habitats at 4th Cliff and maintain their function as natural
 2870 buffers, managers should retain undeveloped transitional and upland habitat in the inland areas surrounding
 2871 coastal wetlands to allow habitat migration to occur which helps preclude the disappearance of coastal
 2872 wetlands. Without unimpeded habitat migration, coastal wetlands and salt marshes may be lost entirely to
 2873 sea level rise and coastal erosion (MEMA and EOEEA 2018, NOAA 2022). Sea level rise projections for
 2874 the area around and including 4th cliff suggest that even under scenarios of moderate rise (~ one foot) would
 2875 inundate much of the salt marsh [south eastsoutheast](#) of the developed portion of the peninsula, higher levels
 2876 would essentially eliminate the wetland (NOAA 2022).

2877 **7.7 Grounds Maintenance**

2878 *Applicability Statement*

2879 This section applies to USAF installations that perform ground maintenance activities that could impact
 2880 natural resources. This section **IS** applicable to this installation.

2881 *Program Overview/Current Management Practices*

2882 **Hanscom AFB, Fourth Cliff Recreation Area, and Sagamore Hill Solar Weather Observatory Annex**

2883 HAFB has a landscape and grounds maintenance plan for aesthetic and operation reasons (HAFB 2020b).
 2884 Areas are categorized as improved ground, semi-improved ground, and unimproved ground, based on the
 2885 frequency and extent of maintenance required. Fertilizer application is limited to improved grounds and is
 2886 applied as specified by the manufacturer's instruction to minimize impacts of non-point source pollution
 2887 associated with fertilizers. Pesticide use is logged IAW with the integrated PMP, using the minimum
 2888 amount necessary.

2889 Grounds maintenance conducted within the 100-foot buffer around wetlands must be coordinated with the
 2890 66 CED, Civil Engineer Installation Management Flight, Environmental Element (66 ABG/CEIE) at least
 2891 10 days prior to [workwork](#).

2892 Tree cutting at [HAFB and the associated GSUs, especially Sagamore Hill](#), is prohibited from 01 June to 31
 2893 July to protect northern long-eared bats and their habitat; any tree cutting from 01 April to 31 October
 2894 requires coordination with 66 ABG CEIE and consultation with USFWS at least 30 days prior to work.
 2895 Hazardous tree removal within a wetland and/or between 01 April and 31 October requires an Emergency
 2896 Hazard Removal Permit from 66 ABG/CEIE.

2897 Landscaping crews will use native species where practical to reduce the maintenance costs and enhance
 2898 habitats for wildlife, including invertebrates. Some non-native ornamental species are currently in use, but
 2899 only non-invasive species will be retained at the installation. Grass species mixtures to be used at HAFB
 2900 include perennial ryegrass, crossbow creeping red fescue (*Festuca rubra*), and Kentucky bluegrass (seed
 2901 mixtures provided in HAFB 2020b). Select tree and shrubs species may be used to ensure continuity of
 2902 landscaping appearance (provided in [Table 7-1](#)). [HAFB will assess the feasibility of developing or sourcing](#)
 2903 [a native seed mix which can be applied to transitional areas between mission areas and natural areas.](#)
 2904 [Transitional areas can serve to benefit fish and wildlife, while also maintaining mission capabilities.](#)

2905 Prior to the 1990s a number of non-native ornamental trees were planted, but since then ornamental tree
 2906 plantings have focused on native hardwood species, such as red maple, silver maple, oaks, and American
 2907 elm (*Ulmus americana*). Burning bush, cypress and euonymus are prohibited for import in the state of
 2908 Massachusetts, but were planted on HAFB prior to 2006. Under the import ban pre-existing plants do not
 2909 need to be destroyed, but ~~can't~~cannot be replaced in kind when they perish (HAFB 2020b); these species
 2910 will be replaced with other plants when needed, with priority going to native species. Climate impacts may
 2911 require changes to species used in grounds maintenance to those better adapted to new environmental
 2912 conditions. Species lists will be periodically reviewed to ensure species can still persist without extensive
 2913 management inputs.

Table 7-1. Landscaping species for use on Hanscom Air Force Base.

Trees	Trees	Shrubs	Shrubs
American Elm (<i>Ulmus americana</i>)*	Locust (<i>Gleditsia</i> spp.)	Andromeda (<i>Pieris</i> spp.)	Rose (<i>Rosa</i> spp.)
Atlantic White Cedar (<i>Chamaecyparis thyoides</i>)*	Magnolia (<i>Magnolia</i> spp.)	Arborvitae (<i>Thuja</i> spp.)	Canada Yew (<i>Taxus canadensis</i>)*
Balsam Fir (<i>Abies balsamea</i>)*	Mountain Ash (<i>Sorbus americana</i>)*	Azalea (<i>Rhododendron</i> spp.)*	
Birch (<i>Betula</i> spp.)*	Northern Hawthorn (<i>Crataegus dissona</i>)*	Barberries (<i>Berberis</i> spp.)	
Cherry (<i>Prunus</i> spp.)*	Oak (<i>Quercus</i> spp.)*	Forsythia (<i>Forsythia</i> spp.)	
Crabapple (<i>Malus</i> spp.)	Pear (<i>Pyrus</i> spp.)	Hemlock (<i>Tsuga</i> spp.)*	
Dogwood (<i>Cornus</i>)*	Plum (<i>Prunus</i> spp.)*	Holly (<i>Ilex</i> spp.)*	
Eastern Red Cedar (<i>Juniperus virginiana</i>)*	Red Maple (<i>Acer rubrum</i>)*	Juniper (<i>Juniperus</i> spp.)*	
Japanese Maple (<i>Acer palmatum</i>)	Silver Maple (<i>Acer saccharinum</i>)*	Mugo Pine (<i>Pinus mugo</i>)	

Table 7-1. Landscaping species for use on Hanscom Air Force Base.

Trees	Trees	Shrubs	Shrubs
Linden (<i>Tilia</i> spp.)	Willow (<i>Salix</i> spp.)*	Rhododendron (<i>Rhododendron</i> spp.)*	

2914 *Native species or native species available.

2915

2916 **7.8 Forest Management**

2917 *Applicability Statement*

2918 This section applies to USAF installations that maintain forested land on USAF property. This section **IS**
 2919 applicable to this installation.

2920 *Program Overview/Current Management Practices*

2921 **Hanscom AFB, Fourth Cliff Recreation Annex, and Sagamore Hill Solar Weather Observatory**
 2922 **Annex**

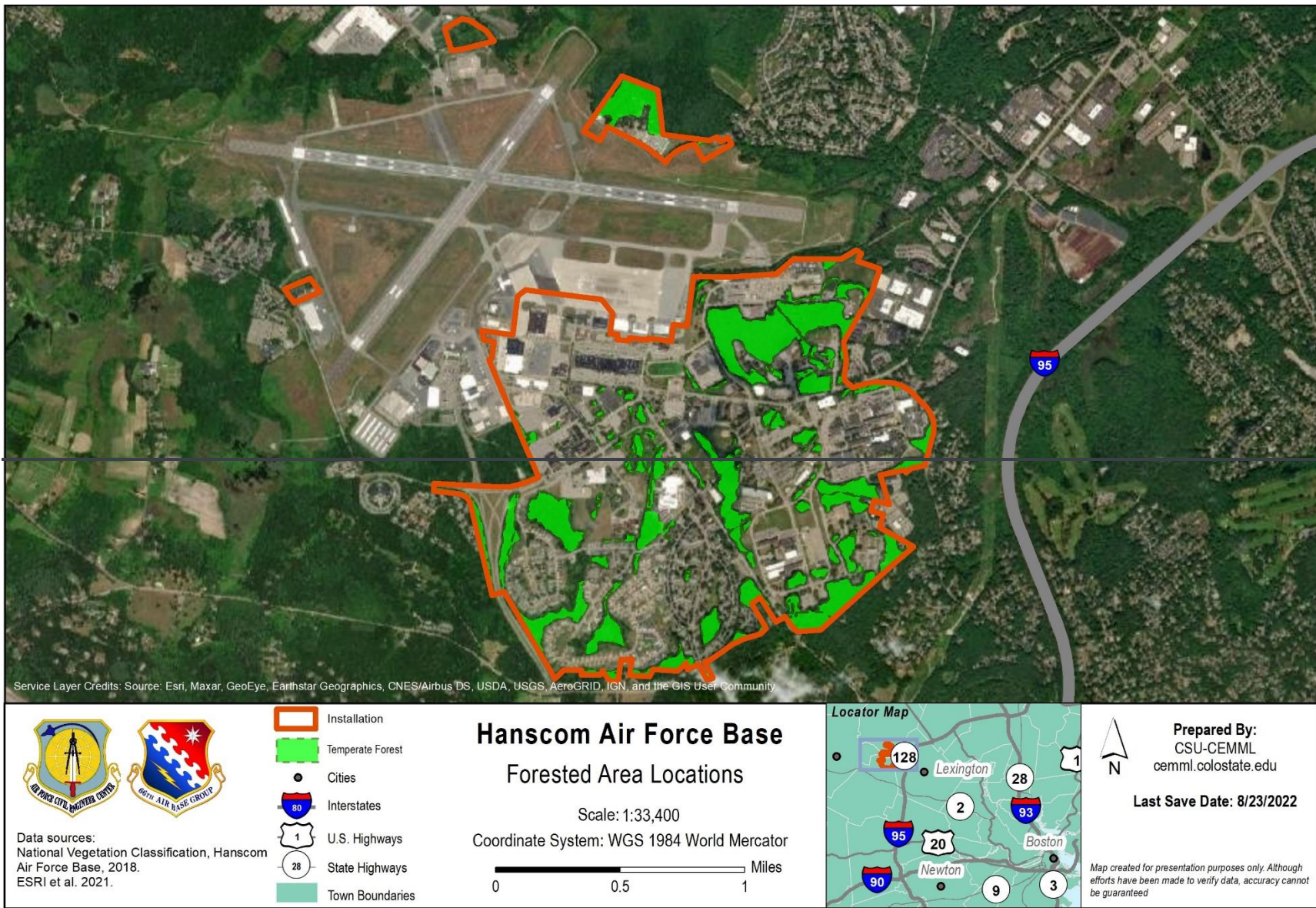
2923 At HAFB, there are approximately 151 acres of fragmented, discrete patches of forest, 60 percent of which
 2924 are composed of mixed hardwoods/softwoods and the remaining 40 percent are composed of either mature
 2925 hardwood, softwood, or American beech (LEC Environmental Consultants, Inc. 1999; [Figure 7-2](#)).
 2926 Currently, HAFB does not have a forest management program for either the main installation or the GSUs
 2927 because the forest area is small and there are no commercial timber harvest opportunities. Furthermore, the
 2928 forested habitats at HAFB and its GSUs provide roosting habitat for T&E bat species and may support
 2929 protected herptile species. The forested patches also provide aesthetic and recreation value for base
 2930 personnel, as there are footpaths that travel in or adjacent to the forests.

2931 Surveys on each GSU are needed to determine whether an active forest management plan is required to
 2932 sustain forests for their wildlife habitat and recreation values. Currently, forest management is restricted to
 2933 maintaining line of sight for aircraft using Hanscom Field, removing tree limbs to protect infrastructure and
 2934 human safety, and maintaining the perimeter fence access road.

2935 The fact that T&E bat species roost in forested habitats at HAFB, 4th Cliff, and Sagamore Hill (detailed in
 2936 [Section 2.3.4](#)) indicates that they require additional management techniques to avoid impacts during the
 2937 bats’ summer roosting season. Currently, any tree limb removal is prohibited from 01 June to 31 July unless
 2938 specifically required for immediate safety hazards, as detailed in [Section 7.7](#).

2939 **7.8.1 Climate Impacts on Forest Management**

2940 Climate impacts on forests are unlikely to require significant changes to forest management practices at
 2941 HAFB or the GSUs. A regular monitoring program for detecting invasive species, emerging pest species,
 2942 and changes in forest species composition would enable rapid detection of issues related to forest
 2943 management under altered environmental conditions.



2944

2945 Figure 7-2. Forested areas of Hanscom Air Force Base.

2946 **7.9 Wildland Fire Management**

2947 *Applicability Statement*

2948 This section applies to USAF installations with unimproved lands that present a wildfire hazard and/or
 2949 installations that use prescribed burns as a land management tool. This section **IS NOT** applicable to this
 2950 installation.

2951 *Program Overview/Current Management Practices*

2952 Wildland fires are uncommon at HAFB and its GSUs, and mission objectives do not create ignition sources
 2953 that could start wildland fires. HAFB maintains a structural fire crew for the base’s developed areas, which
 2954 characterize most of HAFB’s land. The structural fire crew also assists with fire response at the adjacent
 2955 Hanscom Field. Prescribed fire is not used at HAFB or its GSUs; however, if such a program is implemented
 2956 in the future — primarily to maintain grassland areas — this section will need to be updated. If needed in
 2957 the future, the Joint Base McGuire-Dix-Lakehurst Wildland Fire Support Module can assist in the
 2958 development of a prescribed burn plan.

2959 **7.9.1 Climate Impacts on Wildland Fire Management**

2960 There is little need for wildland fire management consideration at HAFB, currently or in the future. The
 2961 landscape is heavily managed and the few acres of wildland fuels that exist are only marginally flammable.
 2962 Combined with a climate that is not conducive to fire, now or in the future, there is nothing to suggest
 2963 wildfire mitigation is necessary.

2964 **7.10 Agricultural Outleasing**

2965 *Applicability Statement*

2966 This section applies to USAF installations that lease eligible USAF land for agricultural purposes. This
 2967 section **IS NOT** applicable to this installation.

2968 *Program Overview/Current Management Practices*

2969 There are no areas suitable for agricultural outleases at HAFB or the GSUs.

2970 **7.11 Integrated Pest Management Program**

2971 *Applicability Statement*

2972 This section applies to USAF installations that conduct pest management activities in support of natural
 2973 resources management (e.g., control of invasive species, forest pests, etc.). This section **IS** applicable to
 2974 this installation.

2975 *Program Overview/Current Management Practices*

2976 **Hanscom AFB, Fourth Cliff Recreation Annex, and Sagamore Hill Solar Weather Observatory**
 2977 **Annex**

2978 HAFB has and implements an integrated PMP for HAFB, 4th Cliff, and Sagamore Hill (HAFB 2020c). The
 2979 integrated PMP addresses control of insects, small vertebrates, large wild animals, flying pests, noxious
 2980 weeds, and invasive species. A number of these pest species can affect natural resources, including
 2981 populations of animals whose populations benefit from anthropogenic activities, such as coyotes, foxes,
 2982 and raccoons, ~~that~~which consume T&E herptiles, as well as invasive plant species that degrade wetland

2983 habitats. [Invasive plants are determined using the MPPL and the invasive or likely invasive plant lists](#)
 2984 [provided by MIPAG](#). Invasive plant species present at HAFB and its GSUs include Tatarian honeysuckle,
 2985 common buckthorn, multiflora rose, garlic mustard (*Alliaria officinalis*), black swallow-wort, tree-of-
 2986 heaven, purple loosestrife, oriental bittersweet (*Celastrus orbiculatus*), Japanese knotweed (*Polygonum*
 2987 *cuspidatum*), [spotted knapweed](#), and common reed ([CEMML 2022b](#)). Invasive plant species spread quickly,
 2988 often forming dense monocultures that outcompete native plants and prevent native species from re-
 2989 establishing. The PMP should be updated to include comprehensive, species-specific control methods for
 2990 invasive plant species that includes a routine monitoring component. CEMML (2022b) provided basic
 2991 species-specific management recommendations to support the update of the invasive plant sections of the
 2992 PMP. Species-specific control methods for black swallow-wort, Japanese knotweed, common reed, purple
 2993 loosestrife, and tree-of-heaven were included.

2994 Central to pest management at HAFB and its GSUs is integrating the use of mechanical, biological,
 2995 chemical, and cultural controls of pest species. Mechanical control involves hand-pulling, cutting, mowing,
 2996 ~~muleh~~[mulching](#), and tilling, and it is effective for small, isolated populations. It can also target individual
 2997 species, minimizing damage to desirable plants and animals. Mechanical control, however, is time and labor
 2998 intensive. ~~Meeh~~[Mechanical](#) control is recommended for small infestations, including the existing black
 2999 swallow-wort infestations at HAFB and Sagamore Hill (CEMML 2022b).

3000 Chemical control involves the use of pesticides and herbicides to eradicate pests. Pesticides and herbicides
 3001 are only applied by licensed pesticide applicators, who must use no more than the manufacturer's minimum
 3002 required application amounts (HAFB 2020c). Chemical controls are not applied when wind speed exceeds
 3003 five miles per hour, are not applied within wetland or water areas unless specifically approved on their
 3004 labels, and only products approved by the PMP Coordinator are used. Contractors conducting chemical
 3005 control at HAFB and the GSUs also must follow these standards (HAFB 2020c). Chemical control plans
 3006 should be species-specific for maximum efficacy, while reducing external impacts. Large infestations of
 3007 Japanese knotweed, common reed, and purple ~~loest~~[loosestrife](#), would benefit from targeted chemical
 3008 control methods that time pesticide application to ensure the pesticides reach the rhizomes of these species.
 3009 Effective eradication of these species will take multiple years of control as they harbor large seed banks
 3010 and will re-grow if the rhizomes aren't killed (CEMML 2022b).

3011 Biological control mostly involves the release of specific insect species that control invasive vegetation by
 3012 feeding on leaves, shoots, and stems to defoliate and eradicate them. Since 2000, *Galerucella* spp. beetles
 3013 have been released in over 30 states, including Massachusetts, to effectively control purple loosestrife. To
 3014 date, *Galerucella* spp. beetles have not been released at HAFB or its GSUs, but they are an option for future
 3015 purple loosestrife control. Such efforts would benefit from community outreach to involve community
 3016 members, including school groups, for releasing beetles and monitoring the results.

3017 Cultural control consists of preventing conditions that encourage pest species from establishing themselves
 3018 in undesirable locations. Cultural control methods at HAFB and the GSUs include reseeding bare ground
 3019 to prevent invasive species from becoming established; securing trash and reducing food sources to
 3020 discourage mammal pest species that prey on T&E species; and closing openings in residential buildings
 3021 to prevent birds and bat species from occupying them and reduce concerns about public health and health
 3022 conflicts with T&E bat species management (HAFB 2020c).

3023 CEMML (2022b) noted that invasive vegetation patches are distributed around the edges of mowed fields
 3024 on HAFB and Sagamore Hill; this is likely the result of contaminated mowing equipment spreading plant
 3025 propagules. The next update to the PMP and Landscape and Grounds Maintenance plan should include

3026 protocols to decontaminate landscaping equipment between areas and additional methods to prevent
3027 grounds maintenance activities from spreading invasive plants.

3028 ***Spotted lanternfly and tree-of-heaven control***

3029 As the current population of tree-of-heaven is low on HAFB, these trees ~~won't~~will not be removed; instead,
3030 they will be used as trap trees for monitoring and controlling spotted lanternfly. Sticky-band traps attached
3031 on tree-of-heaven trunks with modifications to avoid bycatch will be used to routinely monitor for spotted
3032 lanternfly presence and control any spotted lanternfly detected (CEMML 2022c, Pennsylvania Department
3033 of Agriculture n.d).

3034 As spotted lanternflies haven't been detected on HAFB or the GSUs, the current management strategy for
3035 this species is to increase awareness about spotted lanternfly across the installation and develop an early
3036 detection and rapid response plan for controlling them should they be detected.

3037 ***7.11.1 Climate impacts on the Integrated Pest Management Program***

3038 Changes in future climate conditions may allow new pest species and invasive plants to become established
3039 by providing new niches and opening existing ones. Routine surveys for pest species will permit rapid
3040 detection of newly colonizing species and subsequent eradication before they become established.

3041 ***7.12 Bird/Wildlife Aircraft Strike Hazard***

3042 ***Applicability Statement***

3043 This section applies to USAF installations that maintain a BASH program to prevent and reduce wildlife-
3044 related hazards to aircraft operations. This section **IS NOT** applicable to this installation.

3045 ***Program Overview/Current Management Practices***

3046 HAFB uses the airfield at the adjacent Hanscom Field, which is owned and operated by Massport, therefore
3047 an HAFB-specific BASH program is not required. Sagamore Hill and 4th Cliff do not have airfields or
3048 BASH concerns.

3049 Massport maintains a Wildlife Hazard Management Plan and is visited regularly by the United States
3050 Department of Agriculture to evaluate and minimize wildlife hazards to aircraft (Massport 2019, 2020).
3051 Airfield fencing is used to keep larger animals away from the runway. Massport also has a grassland
3052 management plan for discouraging bird use directly adjacent to the runways and taxiways, but also for
3053 providing habitat for upland sandpiper and grasshopper sparrow further from the airfield. The protected
3054 grassland bird species do not usually create BASH concerns because they nest and forage at or near ground
3055 level. Massport are responsible for the grassland management outside of the HAFB boundary and they will
3056 revise grassland management plan if wildlife hazards reach unacceptable levels.

3057 ***7.13 Coastal Zone and Marine Resources Management***

3058 ***Applicability Statement***

3059 This section applies to USAF installations that are located along coasts and/or within coastal management
3060 zones. This section **IS** applicable to this installation.

3061 ***Program Overview/Current Management Practices***

3062 The Coastal Zone Management Act was passed by Congress in 1972 to protect coastal zones of the U.S. It
3063 allows states to develop their own coastal management programs and manage federal consistency reviews

3064 for ensuring that federal projects within the coastal zone conform to state-defined coastal policies. In 1978,
 3065 Massachusetts developed the first coastal management program plan to be approved by NOAA Fisheries
 3066 on the eastern U.S. coast and created the MCZM to administer this plan. The Massachusetts Coastal Zone
 3067 includes “. . . lands and waters within an area defined by the seaward limit of the state's territorial sea [from
 3068 the New Hampshire border south to the Rhode Island border], and landward to 100 feet inland of specified
 3069 major roads, rail lines, other visible rights-of-way, or [at specified coordinates]. . . .”
 3070 (<https://www.mass.gov>). As part of the federal consistency review, MCZM reviews the “coastal effects” of
 3071 federal actions on biological resources, physical resources, and human uses (fishing, boating, public
 3072 access), and ensures their consistency with the state’s coastal policies (MCZM 2011).

3073 All portions of 4th Cliff are within the coastal zone boundary ([Figure 7-3](#)); thus, MCZM review is required
 3074 for federal actions, including development, dredging, construction of coastal engineering structures
 3075 (including flood and erosion control), and improvements on military bases. The procedures for federal
 3076 consistency reviews are as follows (MCZM 2011).

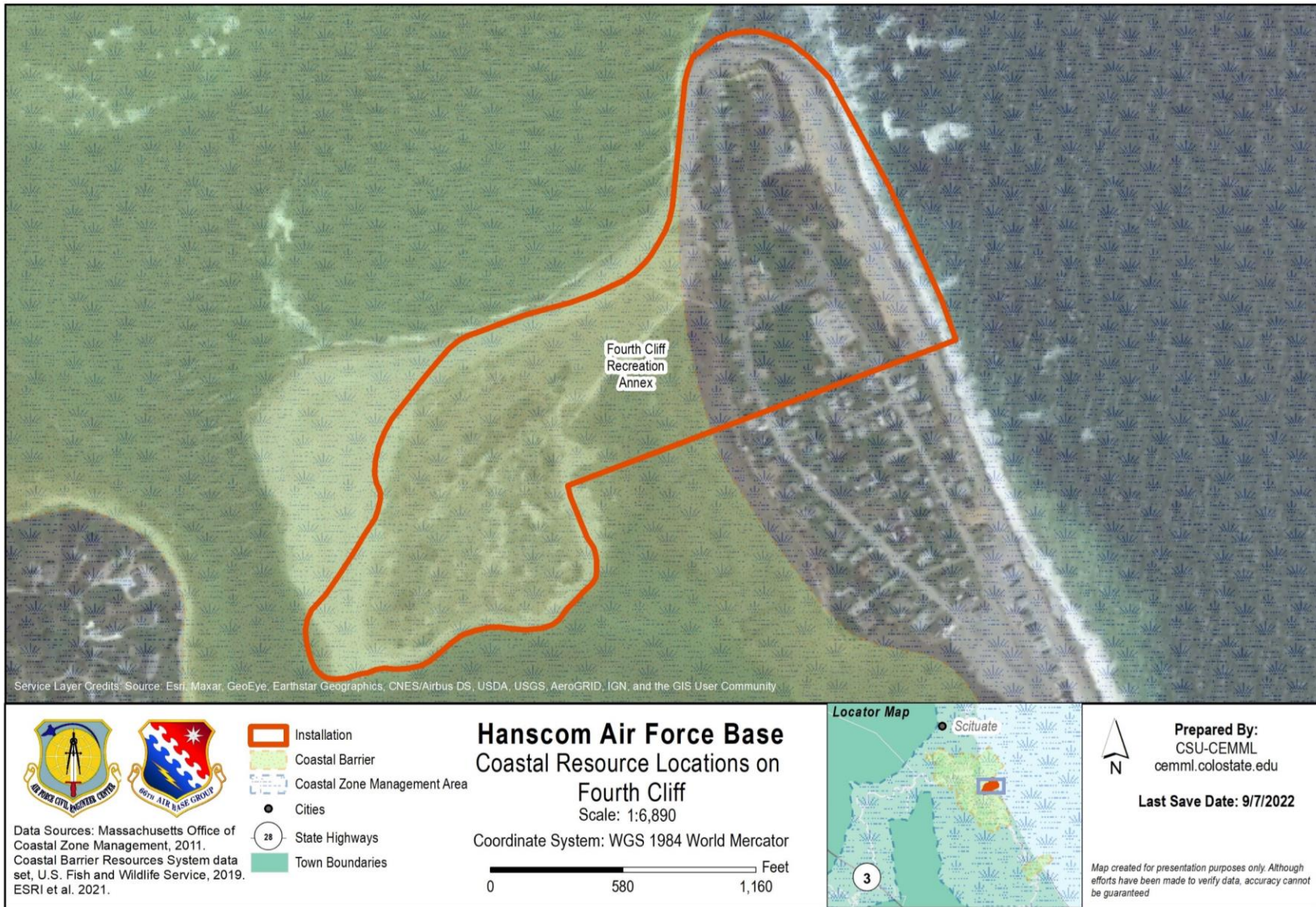
- 3077 • At least 90 days before final approval, USAF submits a consistency determination that specifies
 3078 whether the action will be carried out in a manner consistent with the state’s coastal policies. This
 3079 determination includes a description of the activity, the location of the activity, the relevant
 3080 coastal policies, and the data necessary to support the USAF’s determination.
- 3081 • There is a 21-day opportunity for the public to review and comment on the consistency review.
- 3082 • MCZM will complete its review within 60 days, or a mutually agreed-upon alternative timeframe.
- 3083 • In the event of an objection that the action is inconsistent with the state coastal policies, MCZM
 3084 will issue a decision as to how the action is inconsistent and provide alternative methods that
 3085 would allow the proposed activity to conform to the coastal policies. USAF and MCZM will have
 3086 to establish a resolution before final approval.

3087 Massachusetts coastal policies consist of 26 individual policies within nine policy headings, briefly
 3088 summarized here (MCZM 2011, HAFB 2014).

- 3089 • Coastal Hazard Policies—Protect/restore landforms that provide protection from storm damage;
 3090 minimize impacts to water circulation and sediment transport; protect Coastal Barrier Resources;
 3091 relocate structures out of high-hazard areas and maintain these areas for conservation or
 3092 recreation.
- 3093 • Water-Quality Policies—Ensure that all waste discharge conforms to water-quality standards
 3094 (point source, non-point source, and subsurface), and protects uses of coastal areas.
- 3095 • Habitat Policies—Protect/restore coastal, estuarine, and marine habitats.
- 3096 • Protected Areas Policy—Protect/restore areas of critical environmental concern and protect state-
 3097 designated scenic rivers; ensure that developments respect the preservation intent when occurring
 3098 in registered historic places.
- 3099 • Ports and Harbors Policies—Obtain widest public benefit from channel dredging; preserve water-
 3100 dependent industrial uses of designated port areas; preserve immediate waterfront for vessel-
 3101 related activities; encourage expansion of water-dependent uses in designated ports and harbors.
- 3102 • Public Access Policies—Ensure that development promotes general public use of coastal waters;
 3103 improve access to coastal recreation; expand existing facilities and develop new public areas.
- 3104 • Energy Policies—Site non-coastal energy sources (i.e., land-based wind farms, solar panels, etc.)
 3105 outside of the coastal zone; encourage energy conservation and use of renewable energy sources.

- 3106 • Ocean Resources Policies—Support sustainable aquaculture; oil, gas, and marine mineral
3107 extraction must protect marine resources, marine water quality, fisheries, navigation, and
3108 recreational uses; sand and gravel for beach nourishment or shoreline stabilization should be
3109 extracted offshore without impacting marine resources.
- 3110 • Growth-Management Policies—Development should be consistent with plans to support the
3111 quality and character of the community; infrastructure projects in coastal zone should benefit the
3112 existing areas; revitalization of existing development centers is encouraged.
- 3113

DRAFT



3114

3115 Figure 7-3. Coastal resources at Fourth Cliff Recreation Annex.

3116 **Coastal Barrier Resources**

3117 The Coastal Resources Barrier Act (CRBA) was passed by Congress in 1982 after it was recognized that
 3118 federal actions and programs were encouraging development on coastal barriers, risking human life and
 3119 property. Coastal Barriers are landforms that provide the first line of defense for protecting the mainland
 3120 from severe coastal storms and erosion. The CRBA prevents federal agencies, including the USAF, from
 3121 funding or carrying out any development projects on Coastal Barriers, with some limited exceptions. The
 3122 western beach on 4th Cliff is classed as a Coastal Barrier–Unit C03, established in 1990 (USFWS 2021a).
 3123 Exempted activities that can occur on the Coastal Barrier (after consulting with USFWS) include
 3124 emergency assistance, military activities essential to national security, extracting energy resources, and
 3125 maintaining existing navigational channels (USFWS 2019). The CRBA restrictions also provide indirect
 3126 protection for shorebirds that nest on the Coastal Barrier at 4th Cliff. Current uses of 4th Cliff do not impact
 3127 the Coastal Barrier and are unlikely to in the foreseeable future.

3128 **Coastal America, Marine Animal Protection, Sea Grasses and Artificial Reefs**

3129 The 4th Cliff GSU is not currently part of a Coastal America Partnership, and there are no sea grass habitats
 3130 or artificial reefs within the property boundary (Massachusetts Department of Environmental Protection
 3131 2021, Massachusetts Division of Marine Fisheries 2021). The Coastal America Partnership was established
 3132 by the DoD and USAF to encourage installations to work with partners to establish regional programs for
 3133 the protection and enhancement of coastal resources; successful projects can be submitted for consideration
 3134 of the Coastal America Awards Program. If the blue mussel restoration partnership with the North and
 3135 South Rivers Watershed Association is successful, HAFB will consider nominating it for consideration in
 3136 the Coastal America Awards Program. Several marine mammal species listed by the USESA and/or
 3137 protected under the Marine Mammal Protection Act use the water surrounding 4th Cliff. Current uses by
 3138 the USAF will not affect these species, and any future projects that may affect them will entail consultation
 3139 with NOAA Fisheries. Management techniques for these species are provided in [Section 7.4](#).

3140 *7.13.1 Climate Change Impacts on Current and Future Management Activities*

3141 The greatest impact to 4th Cliff is the existing erosion on the property’s eastern cliffs. Coastal erosion will
 3142 continue under multiple projected climate scenarios, and increase with sea level rise and storm surges
 3143 (MCZM 2013). The USAF issued a Finding of No Significant Impact and Finding of No Practicable
 3144 Alternative to construct a sloping rip-rap revetment on the eastern cliffs, which would address the existing
 3145 erosion problems and projected increases in erosion for the foreseeable future (HAFB 2019c).

3146 Sea level rise and increased storm surges will impact the Coastal Barrier on the western beach of 4th Cliff.
 3147 MCZM used NOAA data to ~~produce~~produce maps showing the extent of projected SLR and it used
 3148 USACE data to map potential storm surge areas for each hurricane category (one–four) under worst-case
 3149 scenarios (MCZM 2021). These maps show that the coastal barrier could be inundated by four feet from
 3150 sea level rise and the current storm surge from a category two, or greater, hurricane (MCZM 2013). The
 3151 conclusion was that the Coastal Barrier is therefore unsuitable for any use beyond the current recreational
 3152 uses, even if other uses could be approved under the CRBA.

3153 **7.14 Cultural Resources Protection**

3154 *Applicability Statement*

3155 This section applies to USAF installations that have cultural resources that may be impacted by natural
 3156 resource management activities. This section **IS** applicable to this installation.

3157 *Program Overview/Current Management Practices*

3158 In the region that is Massachusetts today, there is evidence of Native American presence that dates back
3159 12,000–9,000 years before present. Around the time of European colonization in the early 1600s, the Boston
3160 Basin region was inhabited by myriad Native Americans, including people of the Massachusett (often
3161 spelled as Massachuset), Narragansett, Nahântick (or Nehantucket; commonly spelled by Euro-Americans
3162 as Niantic), Nipmuc, and Wampanoag tribes (Woods 2019, New England Historic Genealogical Society
3163 2021, HAFB 2019d). Native American archaeological sites in the Boston Basin are clustered along water
3164 courses in sites with sandy soils and relatively flat terrain, although the inhabitants' resource usage would
3165 have extended outward from these sites (HAFB 2019d).

3166 The Boston Basin region was one of the first to be colonized by Euro-settlers in the mid-1600s, as it was
3167 near the earliest landfall sites and had protected harbors and marshes that provided hay for livestock feed
3168 (Hall et al. 2002). Estimates of Native American population sizes during that time vary widely, but the
3169 settlers' accounts indicate that much of the Native American population had already begun to succumb to
3170 disease in the first half of the 1600s, and their descriptions of vacant villages and empty forests contributed
3171 to rhetoric of the Americas that the land was unoccupied wilderness ripe for European homesteading (Marr
3172 and Cathey 2010, Snow and Lanphear 1988).

3173 The towns of Bedford, Lincoln, and Concord, which surround the main base, have a rich history of early
3174 American events, including the Battle of Lexington and Concord (19 April 1775) and literature references
3175 to the nearby Walden Pond Reservation, a famous example of a kettle hole formed by retreating glaciers
3176 over 10,000 years ago and memorialized in the writings of Henry David Thoreau (HAFB 2019d). Cultural
3177 resources related to the Battle of Lexington and Concord could still be discovered on HAFB.

3178 World War II also left an enduring mark on the HAFB region when the civilian Boston Auxiliary Airport
3179 at Bedford was created and eventually pressed into military service after the attack on Pearl Harbor. Fighters
3180 based and trained at the new installation were deployed to North Africa, Italy, and southern France. In 1947,
3181 the original installation was divided between the Commonwealth of Massachusetts, which retained a civil
3182 terminal and use of the [air fieldairfield](#), and the USAF, which agreed to maintain and operate it and was
3183 deeded portions of the base and leased others.

3184 The Boston area is also an important locus in the history of modern engineering and technology
3185 development. Partnerships between academic and military researchers lead to significant advances in radar
3186 and radio electronics in particular. Hanscom Field emerged as a center of expertise in the research and
3187 development of electronic command, control, communications, and intelligence systems, which remains a
3188 focus of the installation today. The electronics research conducted by the scientists and technicians at MIT,
3189 including the Air Force Cambridge Research Center and, later, the Lincoln Laboratory, was a valuable asset
3190 to the Army Air Forces by the end of World War II. The Radiation Laboratory of MIT and the Radio
3191 Research Laboratory of Harvard University conducted research and development programs in military radar
3192 and radio electronics. Buildings associated with these groups remain on HAFB and receive protection as
3193 historical structures (HAFB 2019d).

3194 The 4th Cliff annex had a clandestine role in WWII. Originally developed as a summer resort community
3195 in the 1920s, it was annexed by the U.S. Army in 1940 for the development of a waterfront artillery battery
3196 as part of a national program for a coastal defense system. For concealment purposes, military facilities
3197 were designed to blend in with the existing cottage community. An underground bunker was landscaped,
3198 and the fire-control tower and station were concealed within false cottages. Currently, all but one of the
3199 original cottages and most of the WWII buildings have been removed or renovated, with the majority of
3200 structures and buildings having been built after 1979, thus not likely to have historical status or protection
3201 (HAFB 2019d).

3202 AFMAN 32-7003 states that the USAF mission includes protecting our nation's heritage, as well its people
3203 and borders. Therefore, the USAF places a high priority on integrating cultural resources management with
3204 other mission priorities. Activities that protect cultural resources also indirectly support the military mission
3205 by preventing or minimizing conflicts between military operations and resource-protection goals. As stated
3206 in the Integrated Cultural Resources Management Plan (ICRMP) (HAFB 2019d), the Natural and Cultural
3207 Resources Planner (66th ABG/Environmental Management) has overall responsibility for implementing
3208 the Cultural Resources Management Program and is the lead organization for monitoring compliance with
3209 applicable federal, state, and local regulations.

3210 Integration of the ICRMP and the INRMP is essential for meeting the requirements of the National
3211 Historical Preservation Act (54 U.S.C., subchapter III, Protection and Preservation of Resources), the
3212 USESA, NEPA, the Military Lands Withdrawal Act of 1999, AFMAN 32-7003, DoD American Indian and
3213 Alaska Native Policy, and DoDI 4715.03. The most recent HAFB ICRMP was reviewed and updated in
3214 July 2019 (HAFB 2019d).

3215 Federal law protects cultural resources that satisfy government criteria for listing on the National Register
3216 of Historic Places (NRHP). The area around HAFB contains areas of major prehistoric and historic
3217 importance from early Paleoindian sites to Revolutionary War battle sites and Cold War laboratories.
3218 Because of the prehistoric and historic archaeological sites in the vicinity of and on the installation,
3219 inventories have been completed on the main base and its GSUs. In 1992, the inventory identified areas of
3220 high, moderate, and low archaeological sensitivity on the main base with one possible prehistoric site and
3221 potential presence of historical sites. A year later, 4th Cliff was inventoried, and three buildings met the
3222 NHRP criteria. Sagamore Hill was surveyed in 1994, and the majority of the facility was designated as
3223 having low potential for archaeological resources. The exception was discovery of a burial site adjacent to
3224 the southern boundary of the facility, where impacts of construction should be avoided (HAFB 2019d).

3225 Although the installation and GSUs were inventoried to meet the survey requirements, there are still areas
3226 of the installation that remain sensitive for as-yet unidentified archaeological sites that will be afforded
3227 protection if they are inadvertently discovered during mission activity.

3228 The cultural resource inventory at HAFB identified two properties recommended as having NRHP
3229 eligibility: the USAF Cambridge Research Laboratories historic district, which includes multiple buildings
3230 that contribute to the eligibility status, and two eligible buildings in the MIT Lincoln Laboratories. In
3231 addition, the Thomas Nelson Sr. Farm Site in the southwestern section of HAFB is moderately/highly
3232 sensitive for archeological sites. NRHP-eligible buildings also were identified at 4th Cliff, including a
3233 WWII bunker, operations building, and two observation towers.

3234 Federal regulations and USAF policy require that any potential negative effects on cultural resources caused
3235 by mission activities be minimized or mitigated. This could include land-use activities related to natural
3236 resource management, such as forest management, T&E species management, wildland fire suppression,
3237 erosion control, and prescribed burning. The CRM and installation project managers and planners will work
3238 together to identify and manage potential conflicts. Adverse effects to cultural resources resulting from
3239 standard or routine natural resource management activities will be avoided or mitigated by completing AF
3240 Form 332 (HAFB 2019d).

3241 **7.15 Public Outreach**

3242 *Applicability Statement*

3243 This section applies to all USAF installations that maintain an INRMP. The installation **IS** required to
3244 implement this element.

3245 *Program Overview/Current Management Practices*

3246 USAF bases are inextricable from the communities that surround and sustain them, and outreach to the
 3247 public, both on and off base, is a key facet of management. Outreach opportunities, such as education, work
 3248 days, and public access to the base (when safe and feasible) can greatly facilitate the management of the
 3249 base’s natural resources. Public outreach and education should extend to all sectors of the public using the
 3250 base, including school-aged children and associated education programs through the base’s school system,
 3251 educational trainings for base personnel and private-sector contractors/users working on or leasing portions
 3252 of the base, and outreach to neighboring communities to help build visibility and good relations with ~~them~~
 3253 neighboring communities those neighboring communities.

3254 **Hanscom Air Force Base**

3255 Public Affairs regularly posts stories they receive regarding outreach programs and efforts on the official
 3256 Hanscom AFB website. <https://www.hanscom.af.mil/News/> and on the installation’s social media
 3257 platforms. The natural resources manager regular briefs installation leadership on the potential impacts that
 3258 natural resources may have on the installation mission.

3259 **Fourth Cliff Recreation Annex**

3260 Guests at 4th Cliff are provided with information about shorebirds and any beach closures, as this GSU is
 3261 part of the North River Important Bird Area designated by Mass Audubon.

3262 **Sagamore Hill Solar Weather Observatory Annex**

3263 Due to the limited personnel use of Sagamore Hill and lack of public access, there is no public outreach at
 3264 this GSU.

3265 **7.16 Climate Change Vulnerabilities**

3266 *Applicability Statement*

3267 This section applies to USAF installations that have identified risks/vulnerabilities directly or indirectly
 3268 associated with climate change, and adaptation strategies based on authoritative, region-specific climate
 3269 science, climate projections, and existing tools. This section **IS** applicable to this installation.

3270 *Program Overview/Current Management Practices*

3271 Climate vulnerability refers to the degree to which an installation and its natural resources are susceptible
 3272 to the impacts of climate change. Under this definition, installations and their natural resources that are
 3273 more vulnerable will experience greater harm, while those less vulnerable will be less affected or even
 3274 benefit from climate change. Mission-related climate change vulnerabilities were assessed based on both
 3275 literature review and spatial and temporal overlap between projected climate change exposures, associated
 3276 secondary climate change effects, and mission requirements. This section will primarily cover natural
 3277 resource-related impacts from climate change, with particular attention to impacts to operations and any
 3278 potential future impacts from mission expansion. HAFB may be susceptible to the climate-related issues
 3279 listed below.

- 3280 • Decreased water quality and degradation or loss of wetlands.
- 3281 • Loss of coastal land and habitat, and hence recreational opportunities.
- 3282 • Increased occurrence of intense weather events.

- 3283 • Increased likelihood of drought.
- 3284 • Increases in pest and invasive species, including those carrying disease.
- 3285 • Changes in composition of native flora and fauna.
- 3286 • Loss of recreations facilities.
- 3287 • Increased sensitivity of protected species and potentially increased regulatory burden.

3288 HAFB’s mission is to support research and development of air traffic control and weapons systems.
 3289 Supporting functions provided by the 66th Air Base Group, such as security and engineering, could be
 3290 impacted by projected shifts in climate change exposures.

3291 Temperatures at HAFB are projected to increase under all scenarios and timeframes, with minimum,
 3292 maximum, and average temperatures expected to be warmer than the historical baseline every month of the
 3293 year in every scenario. This could impact maintenance requirements for infrastructure (e.g., cooling
 3294 buildings and electrical equipment, repairing heat and weather damage to roads), strain electrical supply,
 3295 and increase drought potential. High temperatures may also disrupt supply chains and increase acquisition
 3296 costs for equipment and infrastructure (Pinson et al. 2020).

3297 Indirect impacts of warmer temperatures could occur on HAFB due to the degradation of natural resources.
 3298 Warmer temperatures are likely to create additional stress on ecosystems and may reduce habitat quality in
 3299 most installation ecosystems through increased prevalence of invasive species. Most vegetation groups at
 3300 the property are expected to be moderately vulnerable under all projected climate change scenarios, and
 3301 may shift due to changes in climate. The anticipated reduction in habitat quality due to climate changes
 3302 could result in an increased regulatory environment, requiring more resources for management and
 3303 monitoring. The vulnerability of ecosystems will depend largely upon the balance between rising
 3304 temperatures and projected summer precipitation changes. Furthermore, warmer temperatures may
 3305 indirectly increase the prevalence of mosquito and tick-borne pathogens on the installation, potentially
 3306 posing health risks for both wildlife and personnel.

3307 Climate change in general is associated with more extreme weather events in many regions. Events of larger
 3308 magnitudes and intensities may occur more frequently under a changing climate (Trenberth 2011),
 3309 damaging infrastructure and increasing the risk of severe erosion. In addition, high winds could damage
 3310 infrastructure and necessitate additional equipment maintenance (Sydeman et al. 2014). The increased
 3311 storm intensities associated with certain climate scenarios could result in precipitation rates that exceed the
 3312 soil’s infiltration capacity, leading to increased flash flooding and inundation. These increased storm
 3313 intensities could also reduce soil stability, thereby damaging infrastructure.

3314 Although summer temperatures are projected to increase at HAFB, mixed projections for precipitation
 3315 make it difficult to anticipate drought trends. Drought can negatively impact military installations in
 3316 numerous ways. Effects include heightened physiological stress in plants and animals, leading to increased
 3317 susceptibility to pests and pathogens and increased risk of vegetation mortality and die-off events (Stein et
 3318 al. 2019). Specific to military readiness, droughts can damage military infrastructure, exacerbate heat-
 3319 related illnesses, increase energy consumption to provide additional cooling for facilities, and lead to cracks
 3320 in the soil that have the potential to rupture utility lines and road surfaces (U.S. DoD 2019, Pinson et al.
 3321 2020). An increase in frequency and intensity of droughts could have substantial impacts to the extensive
 3322 wetland systems on and surrounding HAFB.

3323 Climate change is likely to exacerbate coastal erosion as sea level and wave action rise and the numbers of
 3324 tropical and extratropical storms increase. The buffer that bluffs, beaches, and dunes provide to existing

3325 infrastructure and other habitats decreases as they are eroded. Without substantial mitigation efforts, the
3326 facilities, roads, and water infrastructure at 4th Cliff could be destabilized by coastal erosion and preclude
3327 its use by the military. Rising waves, tides, and currents from sea level rise also threaten the salt marshes at
3328 4th Cliff, which the military is obligated to protect under the Massachusetts Wetlands Protection Act
3329 (MEMA and EOEEA 2018).

3330 Adapting to climate change will require that the installation assess current operations and procedures to
3331 identify gaps that may increase vulnerability to changes in climate and its secondary effects. Once these
3332 gaps are identified, climate change considerations will need to be integrated across all organizational levels
3333 to manage associated risks. Climate change mitigation and adaptation will also require collaboration with
3334 internal and external stakeholders to ensure the installation's mission is not compromised (DoD 2021).
3335 Several resources are available to guide climate change adaptation within the DoD (Naval Facilities
3336 Engineering Command 2017; Stein et al. 2019; Pinson et al. 2020, 2021).

3337 ***7.17 Geographic Information Systems***

3338 *Applicability Statement*

3339 This section applies to all USAF installations that maintain an INRMP, since all geospatial information
3340 must be maintained within the USAF GeoBase system. The installation **IS** required to implement this
3341 element.

3342 *Program Overview/Current Management Practices*

3343 A geographic information system (GIS) is used by Natural Resources staff to assist in natural resources
3344 inventory and management. This GIS incorporates up-to-date geographic and attribute data for HAFB and
3345 the GSUs. The GIS provides the ability to analyze and model pertinent natural resource information to
3346 ensure compatibility between the military mission and natural resource management. Applications are used
3347 to manage biodiversity and assist in preparation of required operational requests to ensure regulatory
3348 compliance. Environmental data sets are maintained by AFCEC (currently under contract with Colorado
3349 State University) with updates from the installation. Data is created and maintained to Spatial Data
3350 Standards for Facilities, Infrastructure, and Environment.

3351 **8.0 MANAGEMENT GOALS AND OBJECTIVES**

3352 The installation establishes long term, expansive goals and supporting objectives to manage and protect
 3353 natural resources while supporting the military mission. Goals express a vision for a desired condition for
 3354 the installation’s natural resources and are the primary focal points for INRMP implementation. Objectives
 3355 indicate a management initiative or strategy for specific long- or medium-range outcomes and are supported
 3356 by projects. Projects are specific actions that can be accomplished within a single year. Also, in cases where
 3357 off-installation land uses may jeopardize USAF missions, this section may list specific goals and objectives
 3358 aimed at eliminating, reducing, or mitigating the effects of encroachment on military missions. These
 3359 natural resources management goals for the future have been formulated by the preparers of the INRMP
 3360 from an assessment of the natural resources, current condition of those resources, mission requirements,
 3361 and management issues previously identified. Below are the integrated goals for the entire natural resources
 3362 program.

3363 The installation goals and objectives are displayed in the ‘Installation Supplement’ section below in a
 3364 format that facilitates an integrated approach to natural resource management. By using this approach,
 3365 measurable objectives can be used to assess the attainment of goals. Individual work tasks support INRMP
 3366 objectives. The projects are key elements of the annual work plans and are programmed into the
 3367 conservation budget, as applicable.

3368 *Installation Supplement – Management Goals and Objectives*

3369 **GOAL 1: INTEGRATE EFFECTIVE NATURAL RESOURCE MANAGEMENT ON THE**
 3370 **INSTALLATION WITH MILITARY MISSION SUSTAINMENT.**

3371 OBJECTIVE 1.1: Fulfill the Sikes Act requirement of maintaining the INRMP as an up-to-date,
 3372 living document.

3373 PROJECT 1.1.1: Plan for and fund annual updates and five-year revisions of the INRMP to
 3374 ensure it remains relevant and useful.

3375 PROJECT 1.1.2: Coordinate with MassWildlife NHESP to submit inventory information for
 3376 state-listed species to MassWildlife/NHESP via Heritage Hub annually or as the data are
 3377 collected.

3378 PROJECT 1.1.3: Review natural resources tabular and spatial databases annually and update
 3379 every three years or as data become available.

3380 PROJECT 1.1.4: Train Natural Resource staff and provide professional development
 3381 opportunities that support awareness of relevant science and policy.

3382 PROJECT 1.1.5: Plan for and fund supplies and equipment necessary to support the INRMP.

3383 OBJECTIVE 1.2: Prepare for impacts of climate change to minimize damage and speed recovery
 3384 from extreme weather and other climate-related phenomena.

3385 PROJECT 1.2.1: Collaborate with other groups on base to integrate climate preparedness into
 3386 future renewal plans for infrastructure (e.g., transportation, energy, and water delivery) and
 3387 ensure that plans are aligned with natural resources management and compatible with the
 3388 mission.

3389 PROJECT 1.2.2: Collaborate with relevant groups on base to ensure that climate change is
 3390 considered in emergency response plans.

3391 OBJECTIVE 1.3: Determine what types of assessment, analysis, and mitigation will protect
3392 recreational and natural resources while addressing current and possible losses resulting from future
3393 coastal erosion at 4th Cliff under a changing climate.

3394 PROJECT 1.3.1: Review existing analyses on suitable erosion mitigation practices and, as
3395 Federal appropriations allow, implement erosion-mitigation practices, such as living coastlines
3396 or shoreline armoring, to prevent erosion driven by sea level rise and increased storm surge
3397 intensity at 4th Cliff and loss of sensitive shorebird species habitat, and to increase habitat
3398 resilience.

3399 PROJECT 1.3.2: Monitor sand depositing and sediment transport at 4th Cliff to assess annual
3400 changes to shorebird habitat area and whether or not supplementation is necessary.

3401 OBJECTIVE 1.4: Develop a natural resources management program for the Patriot Golf course
3402 and incorporate that management into the INRMP.

3403 PROJECT 1.4.1: Evaluate which natural resource categories (wetlands, T&E species, invasive
3404 species etc.) should be prioritized at Patriot Golf course for programing detailed surveys.

3405 PROJECT 1.4.2: Using the results from project 1.4.1, conduct natural resource surveys at
3406 Patriot Golf course.

3407 PROJECT 1.4.3: Determine the feasibility of implementing a ‘monarchs in the rough’
3408 program, which plants native species to support pollinators — including the monarch butterfly
3409 — in the semi-improved and unimproved areas of the golf course.

3410 PROJECT 1.4.4: Incorporate the results of projects 1.4.1 – 1.4.4 into the INRMP.

3411 **GOAL 2: USE AN ECOSYSTEM-BASED MANAGEMENT APPROACH TO SUPPORT FISH,**
3412 **WILDLIFE, AND PLANT SPECIES ON THE INSTALLATION, ESPECIALLY FEDERALLY-**
3413 **AND STATE-LISTED T&E SPECIES, CANDIDATE SPECIES, AND SPECIES OF SPECIAL**
3414 **CONCERN.**

3415 OBJECTIVE 2.1: Determine the presence of fish, wildlife, and invertebrate species on the
3416 installation that are listed at state and/or federal levels as T&E or SSC and quantify their baseline
3417 populations.

3418 PROJECT 2.1.1: Conduct updated acoustic bat surveys in forest habitats on the installation to
3419 determine presence and location of northern long-eared bats, little brown bats, tricolored bats,
3420 and eastern small-footed bats.

3421 PROJECT 2.1.2: Conduct avian point-count surveys to determine the presence and location of
3422 grasshopper sparrows, eastern meadowlarks, upland sandpipers, and sedge wrens (at HAFB)
3423 and golden-winged warblers (at Sagamore Hill).

3424 PROJECT 2.1.3: Conduct surveys to determine the presence and location of wood turtles and
3425 eastern box turtles (at HAFB) and Blanding’s turtles (at HAFB and Sagamore Hill).

3426 PROJECT 2.1.4: Conduct blue-spotted salamander surveys in wetland habitats at HAFB and
3427 Sagamore Hill, focusing on the presence, location, and identification of genetically-pure forms.

3428 PROJECT 2.1.5: Conduct bridle shiner surveys in waterways and wetlands at HAFB.

- 3429 PROJECT 2.1.6: Conduct intricate fairy shrimp surveys in vernal pool habitats at HAFB.
- 3430 PROJECT 2.1.7: Conduct baseline invertebrate surveys across all major vegetation types on
3431 the installation to determine whether any T&E or state-protected invertebrate species are
3432 present.
- 3433 PROJECT 2.1.8: Conduct initial baseline survey of monarch butterfly to determine presence,
3434 and if present, management strategies for future consideration.
- 3435 OBJECTIVE 2.2: Determine population trends, habitat use, and breeding success of sensitive
3436 animal species confirmed on the installation.
- 3437 PROJECT 2.2.1: Every five years, conduct avian grassland and wetland surveys at HAFB and
3438 Sagamore Hill to determine abundance and breeding success of sensitive birds.
- 3439 PROJECT 2.2.2: Conduct annual shorebird surveys at 4th Cliff to determine annual abundance
3440 and breeding success of piping plover; red knot; and common, least, and roseate terns.
- 3441 PROJECT 2.2.3: Every three years conduct basking surveys for wood turtles at HAFB in
3442 spring–summer to determine abundance and trends.
- 3443 PROJECT 2.2.4: If wood turtles are found, conduct a mark-recapture study on wood turtles at
3444 HAFB to determine population size and population trends over time.
- 3445 PROJECT 2.2.5: Every three years, conduct blue-spotted salamander surveys in vernal pools
3446 and wetlands at HAFB to determine trends in population size.
- 3447 OBJECTIVE 2.3: Establish partnerships with state and federal agencies, universities, and NGOs to
3448 improve fish and wildlife management and to advance stewardship opportunities at HAFB and its
3449 GSUs.
- 3450 PROJECT 2.3.1: After completing sensitive species surveys, communicate and coordinate
3451 with the USFWS, MassWildlife, and NHESP to establish and maintain monitoring and
3452 management practices for federal and state T&E species and SSC confirmed at HAFB and its
3453 GSUs.
- 3454 PROJECT 2.3.2: As needed, communicate and coordinate with universities and NGOs to
3455 conduct surveys and research management strategies for fish and wildlife species of concern
3456 and important habitats at HAFB and its GSUs.
- 3457 OBJECTIVE 2.4: Sustain biodiversity of wildlife and their habitats at HAFB and its GSUs.
- 3458 PROJECT 2.4.1: Conduct regular plant, fish, wildlife, and invertebrate surveys at HAFB and
3459 its GSUs every five years to assess trends in population and diversity over time.
- 3460 PROJECT 2.4.2: Develop an adaptive management plan that incorporates both short- and long-
3461 term needs and prioritizes functional diversity, habitat variability, and habitat connectivity.
3462 Determine temporal scale (e.g., annually or seasonally, based on species monitoring needs) at
3463 which the plan will be refined to maximize success under changing climate conditions.
- 3464 PROJECT 2.4.3: Conduct pilot demonstration project to enhance the blue mussel population
3465 at Fourth Cliff and assess annually for survivability and effects on migrating shorebirds.

3466 OBJECTIVE 2.5: Survey for state- and federally-listed T&E plant species and for plants listed as
3467 state SSC, and identify potential habitat areas for all sensitive plant species, including those that
3468 may undergo range expansions as climate changes.

3469 PROJECT 2.5.1: Survey for all potentially occurring, state-listed plant species, and identify
3470 areas that could support these species currently or in the future.

3471 PROJECT 2.5.2: Based on the results of Project 2.5.1, determine a recommended interval for
3472 resurvey (if any is needed) for each potential species based on the amount and quality of the
3473 available habitat and likelihood of detection during the conditions observed over the course of
3474 the survey.

3475 PROJECT 2.5.3: Every five years, conduct small-whorled pogonia surveys in the suitable
3476 habitat patch on Sagamore Hill.

3477 PROJECT 2.5.4: If any federally-listed plants are detected, determine population trends, and
3478 develop management strategies to sustain and enhance populations. If SSC are detected,
3479 sustain, and enhance the population if such management does not conflict with or constrain the
3480 military mission.

3481 **GOAL 3: UNDERSTAND AND MANAGE VEGETATION AND WATER RESOURCES TO**
3482 **ENHANCE, PRESERVE, AND PROTECT HABITATS THAT ARE RESILIENT AND ROBUST**
3483 **UNDER A CHANGING CLIMATE, WHEN COMPATIBLE WITH MAINTAINING A FLEXIBLE**
3484 **MILITARY MISSION.**

3485 OBJECTIVE 3.1: Inventory the extent and quality of native vegetation and wetlands to support
3486 preservation and protection of rare faunal and floral species.

3487 PROJECT 3.1.1: Within five years, classify and map vegetation communities in the
3488 undeveloped portions of HAFB and the GSUs using the NHESP classification system or other
3489 system of sufficient detail to support invertebrate, rare plant, and invasive species survey and
3490 monitoring efforts.

3491 PROJECT 3.1.2: Using the results from project 3.1.1, cross-reference whether vegetation
3492 communities present at HAFB and the GSUs have the potential to provide key habitat to
3493 sensitive flora and fauna. If any existing vegetation communities do provide key habitat,
3494 develop monitoring and management strategies that will preserve, protect, and enhance the
3495 available habitat.

3496 PROJECT 3.1.3: Inventory vegetation resources at 4th Cliff to establish baseline extent and
3497 quality of native vegetation communities and coastal resources that can be used to understand
3498 and monitor recreational use, anticipate erosional threats that may increase with sea level rise
3499 and greater storm severity, and monitor sensitive floral and faunal habitat.

3500 OBJECTIVE 3.2: Develop management plans for any key habitats identified in objective 3.1 on
3501 HAFB and its GSUs. Management should incorporate regional strategies to provide habitat
3502 variability and connectivity that may be crucial for species adapting to climate change.

3503 PROJECT 3.2.1: Communicate and coordinate with the USFWS, MassWildlife, and the
3504 NHESP to develop a wetland-management plan in support of the blue-spotted salamander and
3505 other key habitats already present at HAFB and its GSUs.

3506 OBJECTIVE 3.3: Coordinate with grounds maintenance to support installation landscaping that
3507 incorporates appropriate native species wherever possible to provide habitat for native fauna,
3508 including desirable invertebrates and pollinators.

3509 PROJECT 3.3.1: Compile a list of recommended native landscaping plants that are readily
3510 available, low-maintenance, and easy to establish and add natural-resource value to the built
3511 environment, such as habitat for native wildlife and pollinators.

3512 PROJECT 3.3.2: Work with grounds maintenance and golf course managers to evaluate
3513 landscaping activities and determine whether there are opportunities to incorporate native
3514 species into planting plans, add no-mow areas to the golf course, and reduce the use of
3515 pesticides to the extent possible to protect invertebrate resources, such as pollinators.

3516 PROJECT 3.3.3: Determine the feasibility of developing or sourcing a native seed mix which
3517 can be applied within transition zones between mission areas and natural areas.

3518 OBJECTIVE 3.4: Coordinate with the HAFB stormwater management program to integrate natural
3519 resources management with stormwater management.

3520 PROJECT 3.4.1: Conduct annual meetings with HAFB stormwater management program
3521 personnel to identify mutually beneficial projects and provide technical support to these
3522 projects as needed.

3523 PROJECT 3.4.2: Ensure best management practices are implemented for stormwater runoff in
3524 the Shawsheen River headwaters, with the aim of removing Segment MA83-08 from the EPA
3525 list of Impaired Waterways within five years of implementation.

3526 PROJECT 3.4.3: Cooperate with the U.S. Geological Survey's Massachusetts Water Science
3527 Center to monitor bacterial and nutrient loads at least every five years at the Shawsheen River
3528 Hanscom Field monitoring site to determine the effectiveness of current and recently
3529 implemented BMPs.

3530 **GOAL 4: DEVELOP A ROBUST DETECTION AND MANAGEMENT PROGRAM FOR**
3531 **INVASIVE SPECIES THAT INCLUDES REGULAR INVASIVE SPECIES SURVEYS,**
3532 **EVALUATES LOCALIZED ECOLOGICAL HARM CAUSED BY INVASIVE SPECIES, AND**
3533 **DEVELOPS AND ENACTS STRATEGIES FOR CONTROLLING AND MONITORING**
3534 **INVASIVE SPECIES THAT ARE DETECTED.**

3535 OBJECTIVE 4.1: Survey HAFB and all GSUs for invasive plant species and determine control
3536 strategies for any infestations detected.

3537 PROJECT 4.1.1: Fully survey HAFB and all GSUs for all noxious and invasive plant species
3538 listed by the Massachusetts Invasive Plant Advisory Group and record infestation boundaries
3539 and percent cover.

3540 PROJECT 4.1.2: Based on the results of Project 4.1.1, develop management strategies for
3541 invasive plants that prioritize species for control while considering the implications of climate
3542 change projections and establish effective monitoring protocols for quickly detecting new
3543 introductions.

3544 PROJECT 4.1.3: Develop a treatment plan for ~~an~~ aquatic invasive plants; include all necessary
3545 permits, treatment methods, follow-up restoration protocols, and a monitoring plan that

3546 complies with all wetland-protection regulations and effectively manages the target species
3547 without damage to wetland resources.

3548 PROJECT 4.1.4: Determine the availability of resources for annual invasive control efforts that
3549 include the highest-priority invasive plant species and sufficient monitoring to inform treatment
3550 methods and document progress.

3551 PROJECT 4.1.5: Plan for and fund annual control efforts for invasive plant species, and plan
3552 for and fund a full survey for invasive plant species at HAFB and its GSUs every five years or
3553 at the interval indicated by surveys.

3554 OBJECTIVE 4.2: Survey HAFB and its GSUs for invasive pests, including invertebrates,
3555 nematodes, and snails, and determine control strategies for any infestations detected.

3556 PROJECT 4.2.1: Fully survey HAFB and its GSUs for all state-listed introduced pests,
3557 particularly the spotted lantern fly (*Lycorma delicatula*), and map potential habitat and
3558 locations of host species.

3559 PROJECT 4.2.2: Using the results of Project 4.2.1, develop control strategies and/or early-
3560 detection protocols, as appropriate, and fund control efforts, as needed.

3561 **GOAL 5: ENHANCE RECREATION OPPORTUNITIES AND OUTREACH THAT SUPPORT**
3562 **NATURAL RESOURCES AWARENESS AMONG BASE PERSONNEL AND THE GENERAL**
3563 **PUBLIC.**

3564 OBJECTIVE 5.1: Leverage volunteer involvement to support pollinator populations and raise
3565 awareness of pollinators on the installation.

3566 PROJECT 5.1.1: Establish a pollinator garden that hosts native flowering plants recommended
3567 for the region by the Xerces Society, contains nesting materials for native bees, and is free from
3568 pesticide use.

3569 PROJECT 5.1.2: Initiate an annual citizen science-based count of monarch butterflies and/or a
3570 pollinator count at the pollinator garden and/or any pollinator-friendly landscaping areas to
3571 collect data at a low cost and to raise awareness of pollinator issues.

3572 OBJECTIVE 5.2: Enhance natural resources-related public outreach opportunities at 4th Cliff.

3573 PROJECT 5.2.1: Develop/update signage related to shorebirds and the North River IBA for
3574 guests at 4th Cliff.

3575 PROJECT 5.2.2: Develop/update information on nature trails adjacent to Hartwell Town
3576 Forest, George Jordan Conservation Area, Bedford Mass. Include signage, trail maps and town
3577 forest rules and regulations.

3578 **GOAL 6: MANAGE NUISANCE WILDLIFE AND PREDATORS IMPACTING BASE**
3579 **OPERATIONS OR AFFECTING MANAGED SPECIES HABITAT.**

3580 OBJECTIVE 6.1: Reduce predation of shorebirds and their habitat at Fourth Cliff

3581 PROJECT 6.1.1: Implement a program (capture or take) to address predation of shorebirds and
3582 their habitat at Fourth Cliff

3583 OBJECTIVE 6.2: Identify and manage nuisance wildlife having effects on base operations.

3584
3585

PROJECT 6.2.1: Continue efforts to control Canada Geese populations affecting base operations in coordination with USDA.

DRAFT

3586 **9.0 INRMP IMPLEMENTATION, UPDATE, AND REVISION PROCESS**

3587 **9.1 *Natural Resources Management Staffing and Implementation***

3588 Responsibility for INRMP implementation can involve several installation organizations. Each responsible
3589 organization and their associated planning, programming, budgeting, and execution programs implement
3590 the INRMP.

- 3591 • 66 CEI, Installation Management is responsible for updates and routing the INRMP for
3592 signatures.
- 3593 • 66 ABG/CE has the primary responsibility for execution and management of the INRMP and is
3594 the Office of Primary Responsibility for managing, coordinating, and negotiating all USFWS-,
3595 MassWildlife-, and NOAA Fisheries-related permitting, agreements, studies, surveys, and
3596 associated mitigation actions for base projects and management activities.
- 3597 • Other offices also have direct responsibility for execution of many programs including Pest
3598 Management, Grounds Maintenance, 66 FSS, Public Affairs, and Security Forces.
- 3599 • Natural resources management should be managed directly by a program manager holding a
3600 degree in the natural sciences, per AFMAN 32-7003, Section 3.11—*INRMP Implementation* if
3601 unit manning documents allow.
- 3602 • Funding, execution, and implementation of INRMP projects, for which the Office of Primary
3603 Responsibility is identified as CEIEC ([Section 10, Annual Work Plans](#)), occurs through contracts
3604 and cooperative agreements funded by the Environmental Quality Operations & Maintenance
3605 annual USAF budget managed by Air Force Civil Engineer Center /Environmental Operations
3606 West Region. Funding for INRMP projects is dependent on federal appropriations.
- 3607 • In accordance with Section 101(d)(2) of the Sikes Act, when acquiring services to implement and
3608 enforce an INRMP, priority shall be given to federal and state agencies responsible for
3609 conserving or managing the fish and wildlife resources covered by the INRMP, provided those
3610 agencies are interested in and capable of providing the services. If no such federal or state agency
3611 expresses an interest in providing the needed implementation or enforcement service or meets the
3612 evaluation criteria, the work may be awarded to another entity through the competitive-selection
3613 procedures outlined in Federal Acquisition Regulations or DoD Grants and Agreements
3614 Regulations, as appropriate (Assistant Secretary of Defense 2016). HAFB discusses upcoming
3615 projects with the USFWS, MassWildlife, and NOAA Fisheries during their Annual INRMP
3616 Review meeting to determine interest in executing projects.

3617 **9.2 *Monitoring INRMP Implementation***

3618 Monitoring, coordination with regulators, and recordkeeping are the primary responsibility of the 66 CE
3619 Division. The 66 ABG/CE is primarily responsible for INRMP updates and implementation.

- 3620 • Natural resources management staffing—Annual updates, including updates to the work plan, are
3621 managed by 66 ABG/CE staff and other offices as needed.
- 3622 • Five-year revisions require review and analysis and require input from offices across the base,
3623 regulators, and interested parties, and signatory approvals are required from USFWS,
3624 MassWildlife, and NOAA Fisheries.

3625 The 66 ABG/CE Program Managers are Subject Matter Experts that implement various portions of the
 3626 INRMP individually and collaboratively. Listed below are trainings that would benefit most, if not all, staff
 3627 and program management.

- 3628 • Air Force Institute of Technology’s WENV 450 EIAP Course—The objective of this course is for
 3629 each student to comprehend the USAF EIAP and its procedures for determining, documenting,
 3630 and disclosing the environmental impacts of proposed USAF actions.
- 3631 • Wetland-Delineation Training—HAFB environmental staff would benefit from having employees
 3632 trained in this area due to the large number of wetlands on the base.
- 3633 • DoD Natural Resources Compliance—As required by AFMAN 32-7003, Section 3.76—*Natural*
 3634 *Resources Training*, all individuals assisting with natural resources management will complete
 3635 *DoD Natural Resources Compliance*, endorsed by the DoD Interservice Environmental Education
 3636 Review Board, and offered for all DoD Components by the Naval CECOS. See
 3637 <http://www.netc.navy.mil/centers/csfe/cecos/> for CECOS course schedules and registration
 3638 information.

3639 **9.3 Annual INRMP Review and Update Requirements**

3640 The INRMP requires annual review IAW DoDI 4715.03, *Natural Resources Conservation Program*, and
 3641 AFMAN 32-7003 to ensure the achievement of mission goals, verify the implementations of projects, and
 3642 establish any necessary new management requirements. This process involves installation natural resources
 3643 personnel and external agencies working in coordination to review the INRMP. If the installation mission
 3644 or any of its natural resources management issues change significantly after the original INRMP is
 3645 developed, a major revision to the INRMP is required. The need to accomplish a major revision is normally
 3646 determined during the annual review with USFWS, MassWildlife, and NOAA Fisheries. The NRM/Point
 3647 of Contact documents the findings of the annual review in an Annual INRMP Review Summary and obtains
 3648 signatures from the coordinating agencies on review findings. By signing the Annual INRMP Review
 3649 Summary, the collaborating agency representatives assert concurrence with the findings. If any agency
 3650 declines to participate in an on-site annual review, the NRM submits the INRMP for review along with the
 3651 Annual INRMP Review Summary document to the agency via official correspondence and request return
 3652 correspondence with comments/concurrence.

3653 AFMAN 32-7003, Section 3.8—*Integrated Natural Resources Management Plan Annual Review and*
 3654 *Coordination*, states that the Annual INRMP Review Summary must include the following information.

- 3655 • Provide a summary of specific INRMP accomplishments since the last INRMP annual review.
- 3656 • Provide an update of the Annual Work Plan for implementing the INRMP that includes the
 3657 current year and at least four future fiscal years. The Annual Work Plan must include all projects
 3658 and activities identified as essential for the successful implementation of INRMP goals and
 3659 objectives, and an implementation schedule that is realistic and practicable. The Annual Work
 3660 Plan may include a consensus by the collaborating agencies on relative project priority (High,
 3661 Medium, or Low) for projects in the Annual Work Plan based on the significance of the project
 3662 for attaining the INRMP goals and objectives.
- 3663 • Projects rated as High in the Annual Work Plan are essential for achieving INRMP goals and
 3664 objectives in the year they are programmed. Sikes Act cooperating agencies would consider the
 3665 INRMP to not be implemented if the project is not accomplished in the year programmed.
- 3666 • Projects rated as Medium in the Annual Work Plan are actions that cooperating agencies agree
 3667 are important for achieving INRMP goals and objectives, but the projects may be deferred if not
 3668 completed in the programmed year.

- 3669 • Projects rated as Low in the Annual Work Plan support INRMP goals and objectives and enhance
3670 the natural resources program, but cooperating agency partners would agree that the activity is
3671 not deemed essential to implement INRMP goals and objectives.
- 3672 • Provide a statement indicating the projects in the Annual Work Plan for which the collaborating
3673 agencies have expressed an interest in participating in project execution. As indicated in the Sikes
3674 Act (16 USC §670a(d)(2)), priority shall be given to federal and state agencies having
3675 responsibility for conservation and management of fish and wildlife for executing INRMP
3676 implementation and enforcements. If the collaborating agencies do not express an interest in
3677 executing projects in the Annual Work Plan, the following statement shall be included in the
3678 Annual INRMP Review Summary: “The execution strategy for the Annual Work Plan has been
3679 discussed with the participating agencies, and the agency representatives have not expressed an
3680 interest in participating in project execution, and agree that implementation will be performed
3681 through other authorized acquisition methods.”
- 3682 • Provide a statement asserting whether or not sufficient numbers of qualified natural resources
3683 management and enforcement personnel and resources are available to oversee implementation of
3684 projects and activities identified in the INRMP Work Plan.
- 3685 • Provide a summary of any required updates to the INRMP determined necessary to keep the
3686 INRMP current in operation and effect for the management of installation natural resources; or
3687 alternatively, include a statement that significant changes to the installation mission or natural
3688 resources goals require an INRMP revision.

3689 An INRMP Annual Review Summary may substitute for the more formal five-year review for Sikes Act
3690 compliance, provided that the INRMP Annual Review Summary lists all updates made to the INRMP since
3691 the last review and the installation documents signatures by the installation commander (or designee) and
3692 the authorized signatory representatives of the USFWS, MassWildlife, and NOAA Fisheries.

3693 The HAFB NRM, USFWS, MassWildlife, and NOAA Fisheries conduct an annual INRMP review meeting.
3694 This meeting takes place in person with respective representatives for each agency. Individuals may
3695 telephone or video call if they cannot attend in person. During this meeting, the NRM updates the external
3696 stakeholders/parties with the end-of-the-year execution report and coordinates future work plans and any
3697 necessary changes to management methods. All parties review the INRMP and begin preliminary
3698 collaborative work on updating the INRMP (e.g., new policies, procedures, impacts, mitigations), as
3699 applicable. Following completion of annual updates, the INRMP is routed for signature by the Installation
3700 Commander or delegate. The environmental program’s Signatory Authority Delegation Letter also shall be
3701 updated as needed. In order for the INRMP to remain in compliance with the Sikes Act, it must be signed
3702 at least once every five years by authorized signatories of the USFWS (Field Supervisors per Delegation
3703 Memo 22 June 2009), MassWildlife and the USAF (Installation Commander or delegate). INRMP
3704 compliance with DoDI 4715.03 and AFMAN 32-7003 also requires signature approval by NOAA Fisheries
3705 (First-Line Supervisor for Technical Assistance Documents per Stelle, 01 October 2013). The Installation
3706 Commander approves the INRMP prepared pursuant to the Sikes Act, Section 101(a)(2). The Installation
3707 Commander may re-delegate signature authority to a lower level provided that the signatory has control
3708 over all aspects and management objectives addressed within the subject INRMP, but no lower than the
3709 Support Group commander. (AFMAN 32-7003, Section 1.14.8).

3710 **10.0 ANNUAL WORK PLANS**

3711 The INRMP Annual Work Plans are included in this section. These projects are listed by fiscal year,
 3712 including the current year and four succeeding years. For each project and activity, a specific timeframe for
 3713 implementation is provided (as applicable), as well as the appropriate funding source and priority for
 3714 implementation. The work plans provide all the necessary information for building a budget within the
 3715 USAF framework. Priorities are defined as follows.

- 3716 • High—The INRMP signatories assert that, if the project is not funded, the INRMP is not being
 3717 implemented and the USAF is non-compliant with the Sikes Act; or that it is specifically tied to
 3718 an INRMP goal and objective and is part of a “Benefit of the Species” determination necessary
 3719 for USESA Sec 4(a)(3)(B)(i) critical habitat exemption.
- 3720 • Medium—The project supports a specific INRMP goal and objective and is deemed by INRMP
 3721 signatories to be important for preventing non-compliance with a specific requirement within a
 3722 natural resource law or by EO 13112, *Exotic and Invasive Species*; however, the INRMP
 3723 signatories would not contend that the INRMP is not being implemented if not accomplished
 3724 within the programmed year as a result of other priorities.
- 3725 • Low—The project supports a specific INRMP goal and objective, enhances conservation
 3726 resources or the integrity of the installation mission, and/or supports long-term compliance with
 3727 specific requirements within a natural resource law, but it is not directly tied to specific
 3728 compliance within the proposed year of execution.

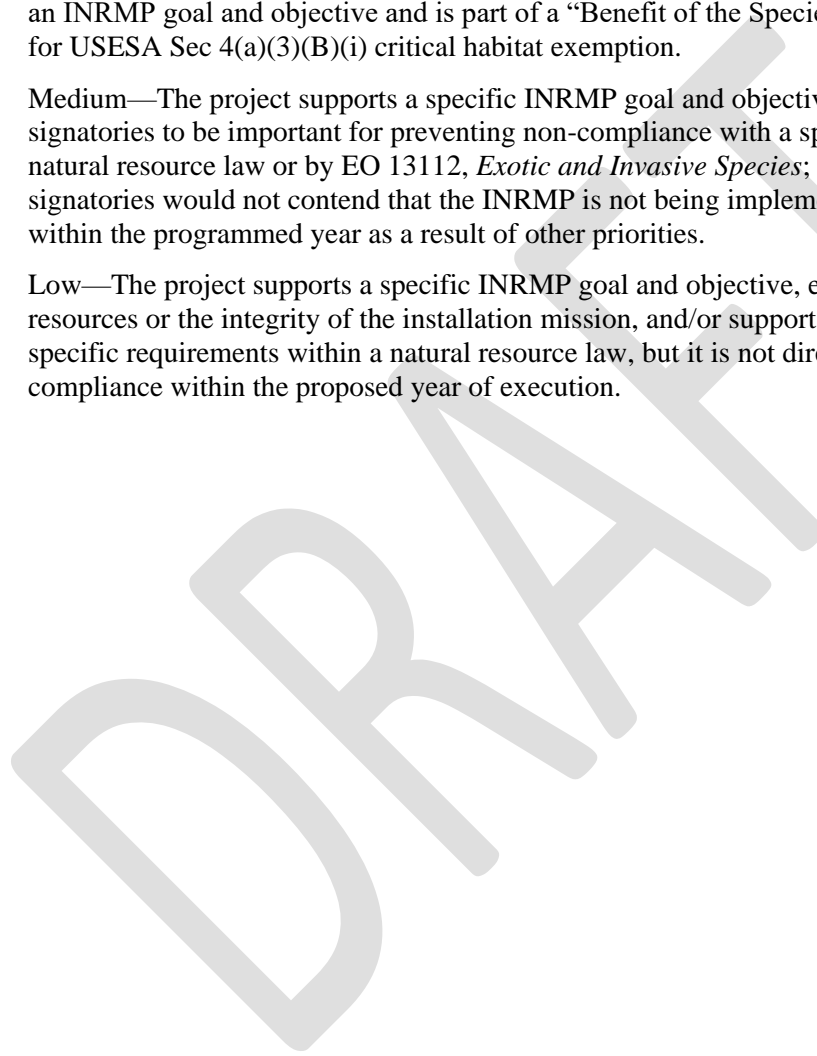


Table 10-1. Annual Work Plan.

Resource Category	Goal	Objective	Occurrence	FY	Office of Primary Responsibility	Funding Source	Priority Level	PB28 Code*	Standard Title*	Project Number	Description
	1	1.1	One Time	2022	66 ABG/CEIEA	AFCEC	High	INRP	Plan Update, INRMP	MXRDA53216115	Develop and coordinate initial Sikes Act-compliant INRMP
T & E Species, Species Mgt	2	2.1; 2.5	Annual	2022	66 ABG/CEIEA	AFCEC	High	T&E	Management, Species	MXRDA53227119	Conduct shorebird surveys on the barrier beach at 4th Cliff to determine the location and recovery statistics of piping plovers; red knots; and least, common, and roseate terns. Efforts to include blue mussel establishment
T & E Species, Species Mgt	2.	2.6	One time	2022	66 ABG/CEIEA	AFCEC	High	T&E	Management, Species	MXRDA53216115	Survey for potentially occurring, state-listed plant species, and identify areas that could support these species currently or in the future
T & E Species, Species Mgt	2	2.1; 2.5	Annual	2023	66 ABG/CEIEA	AFCEC	High	T&E	Management, Species	MXRDA53237119	Conduct shorebird surveys on the barrier beach at 4th Cliff to determine the location and recovery statistics of piping plovers; red knots; and least, common, and roseate terns. Efforts to include blue mussel establishment
T & E Species, Species Mgt, Habitat Mgt	1	1.1	One time	2024	66 ABG/CEIEA	AFCEC	High	INRP	Equipment Purchase / Maintain, CN	MXRDA53246111	Minor equipment purchase GIS units to support natural resources program (GPS units, safety gear, field tablet, binoculars)
T & E Species, Species Mgt, Habitat Mgt	1	1.1	Annual	2024	66 ABG/CEIEA	AFCEC	High	INRP	Vehicle Leasing, CN	MXRDA53246112	Leased vehicle for natural resources program
T & E Species, Species Mgt, Habitat Mgt	1	1.1	Annual	2024	66 ABG/CEIEA	AFCEC	High	INRP	Vehicle Fuel & Maintenance, CN	MXRDA53246113	Maintenance and fuel for leased vehicle for natural resources program
T & E Species, Species Mgt, Habitat Mgt	1	1.1	Annual	2024	66 ABG/CEIEA	AFCEC	High	INRP	Supplies, CN	MXRDA5324619	Supplies to support natural resources program
T & E Species, Species Mgt, Habitat Mgt	1	1.1	Annual	2024	66 ABG/CEIEA USFWS	AFCEC	High	INRP	Interagency/Intra-agency, Government, Sikes Act	MXRDA5324616	On site USFWS support
Mgt, Habitat Mgt	1	1.4	Annual	2024	66 ABG/CEIEA	AFCEC	High	T&E	Management, Habitat	MXRDA53247118	Conduct annual survey/analysis of shorebird habitat, including sediment transport, to monitor effects of erosion and erosion control project; necessary to determine if sediment supplementation is needed
T & E Species, Species Mgt, Habitat Mgt	2	2.1	One time	2024	66 ABG/CEIEA	AFCEC	Low	T&E	Management, Species	MXRDA53247119	Conduct follow up BSS surveys in wetland habitats at HAFB and Sagamore Hill, focusing on the presence, location, and identification of genetically-pure forms.
T & E Species, Species Mgt,	2	2.1	One time	2024	66 ABG/CEIEA	AFCEC	Medium	INRP	Management, Species	MXRDA53236120	Conduct initial survey for proposed ESA listing of monarch butterfly. Include report on future management recommendations and habitat protection/enhancement.
T & E Species, Species Mgt, Habitat Mgt	2	2.1	One time	2024	66 ABG/CEIEA	AFCEC	Medium	T&E	Management, Species	MXRDA53247119	Conduct 5-year update of the acoustic bat surveys in forest habitats on the installation to determine presence and location of NLEBs, LBBs, tricolored bats, and eastern small-footed bats.
T & E Species, Species Mgt, Habitat Mgt	2	2.1; 2.5	Annual	2024	66 ABG/CEIEA	AFCEC	High	T&E	Management, Species	MXRDA53247119	Conduct shorebird surveys on the barrier beach at 4th Cliff to determine the location and recovery statistics of piping plovers; red knots; and least, common, and roseate terns. Efforts to include blue mussel monitoring.
T & E Species, Species Mgt, Habitat Mgt	2	2.1	One time	2024	66 ABG/CEIEA	AFCEC	Medium	T&E	Management, Species	MXRDA53247119	Conduct surveys to determine the presence and location of wood turtles and eastern box turtles (at HAFB) and Blanding's turtles (at HAFB and Sagamore Hill). If present, develop future projects for management.
Invasive Species Mgt	4	4.1	One time	2024	66 ABG/CEIEA	AFCEC	Medium	INRP	Management, Invasive Species	MXRDA53246121	Survey HAFB and all GSUs for invasive plant species and determine control strategies for any infestations detected. Include quantification to baseline presence to evaluate eradication and control efforts in the future. Include report on treatment plans and follow-up restoration protocol, and monitoring plan for future evaluation.
Wetland Mgt	4	4.1	One time	2024	66 ABG/CEIEA	AFCEC	High	WTLD	Management, Wetlands / Floodplains	MXRDA5324915	Golf course wetland rehabilitation, phase 1 (of 3)

Table 10-1. Annual Work Plan.

Resource Category	Goal	Objective	Occurrence	FY	Office of Primary Responsibility	Funding Source	Priority Level	PB28 Code*	Standard Title*	Project Number	Description
Invasive Species Mgt	4	4.2	One time	2024	66 ABG/CEIEA	AFCEC	Medium	INRP	Management, Invasive Species	MXRDA53246121	Fully survey HAFB and its GSUs for all invasive insect species, particularly the spotted lantern fly (<i>Lycorma delicatula</i>), and map potential habitat and locations of host species. Include a report on develop control strategies and/or early-detection protocols.
Outreach	5	5.1; 5.2	Annual	2024	66 ABG/CEIEA	AFCEC	Low	MNRA	Outreach	MXRDA53248114	Public outreach and other public natural resources engagement and outreach supporting materials
Nuisance Species Mgt, T&E Species Mgt	6	6.1	Annual	2024	66 ABG/CEIEA	AFCEC	Medium	T&E	Management, Nuisance Wildlife	MXRDA53247122	Predation control at Fourth Cliff to protect ESA listed shorebird species
T & E Species, Species Mgt, Habitat Mgt	1	1.1	Annual	2025	66 ABG/CEIEA USFWS	AFCEC	High	INRP	Interagency/Intra-agency, Government, Sikes Act	MXRDA5325616	On site USFWS support
T & E Species, Species Mgt, Habitat Mgt	1	1.4	Annual	2025	66 ABG/CEIEA	AFCEC	High	T&E	Management, Habitat	MXRDA53257118	Conduct annual survey/analysis of shorebird habitat, including sediment transport, to monitor effects of erosion and erosion control project; necessary to determine if sediment supplementation is needed
T & E Species, Species Mgt, Habitat Mgt	2	2.1	Annual	2025	66 ABG/CEIEA	AFCEC	High	T&E	Management, Species	MXRDA53257119	Conduct shorebird surveys on the barrier beach at 4th Cliff to determine the location and recovery statistics of piping plovers; red knots; and least, common, and roseate terns.
T & E Species, Species Mgt,	2	2.1	One time	2025	66 ABG/CEIEA	AFCEC	Medium	T&E	Management, Species	MXRDA53257119	Conduct IFS surveys in vernal pool habitats at HAFB. If present, develop future projects for management.
T & E Species, Species Mgt,	2	2.1	One time	2025	66 ABG/CEIEA	AFCEC	Low	T&E	Management, Species	MXRDA53257119	Conduct baseline invertebrate surveys across all major vegetation types on the installation to determine whether any T&E or state-protected invertebrate species are present. If present, develop future projects for management.
T & E Species, Species Mgt,	2	2.2	Annual	2025	66 ABG/CEIEA	AFCEC	High	T&E	Management, Species	MXRDA53257119	Develop and manage species identified in the surveys conducted in preceding years
T & E Species, Species Mgt, Habitat Mgt	2	2.5	Annual	2025	66 ABG/CEIEA	AFCEC	High	T&E	Management, Habitat	MXRDA53257118	Forth Cliff Blue Mussel restoration demonstration project
Wetland Mgt	4	4.1	One time	2025	66 ABG/CEIEA	AFCEC	High	WTLD	Management, Wetlands / Floodplains	MXRDA5325915	Golf course wetland rehabilitation, phase 2 (of 3)
Invasive Species Mgt	4	4.1	Annual	2025	66 ABG/CEIEA	AFCEC	High	INRP	Management, Invasive Species	MXRDA53256121	Annual invasive species control and eradication
Species Mgt, Habitat Mgt	5	5.1	One-time	2025	66 ABG/CEIEA	AFCEC	Low	INRP	Management, Habitat	MXRDA53256119	Establish initial pollinator flyways at HAFB properties. To be maintained in the future through volunteer effort/efforts
Outreach	5	5.1; 5.2	Annual	2025	66 ABG/CEIEA	AFCEC	Low	MNRA	Outreach	MXRDA53258114	Public outreach and other public natural resources engagement and outreach supporting materials
Nuisance Species Mgt, T&E Species Mgt	6	6.1	Annual	2025	66 ABG/CEIEA	AFCEC	Medium	T&E	Management, Nuisance Wildlife	MXRDA53257122	Predation control at Fourth Cliff to protect ESA listed shorebird species
Plan Update	1	1.1	One time	2026	66 ABG/CEIEA	AFCEC	High	INRP	Plan Update, INRMP	MXRDA53266115	Major 5-year ^{5-year} update of INRMP
T & E Species, Species Mgt, Habitat Mgt	1	1.1	Annual	2026	66 ABG/CEIEA USFWS	AFCEC	High	INRP	Interagency/Intra-agency, Government, Sikes Act	MXRDA5326616	On site USFWS support
T & E Species, Species Mgt, Habitat Mgt	1	1.4	Annual	2026	66 ABG/CEIEA	AFCEC	High	T&E	Management, Habitat	MXRDA53267118	Conduct annual survey/analysis of shorebird habitat, including sediment transport, to monitor effects of erosion and erosion control project; necessary to determine if sediment supplementation is needed
Wetland Mgt	1	1.4	One time	2026	66 ABG/CEIEA	MILCON	High	WTLD	Management, Wetlands / Floodplains	MXRDA5326915	Implement Phase 2 Erosion Control Project at Fourth Cliff (northern tip of property)

Table 10-1. Annual Work Plan.

Resource Category	Goal	Objective	Occurrence	FY	Office of Primary Responsibility	Funding Source	Priority Level	PB28 Code*	Standard Title*	Project Number	Description
T & E Species, Species Mgt, Habitat Mgt	2	2.1	Annual	2026	66 ABG/CEIEA	AFCEC	High	T&E	Management, Species	MXRDA53267119	Conduct shorebird surveys on the barrier beach at 4th Cliff to determine the location and recovery statistics of piping plovers; red knots; and least, common, and roseate terns.
T & E Species, Species Mgt,	2	2.2	Annual	2026	66 ABG/CEIEA	AFCEC	High	T&E	Management, Species	MXRDA53267119	Develop and manage species identified in the surveys conducted in preceding years
T & E Species, Species Mgt,	2	2.1	One time	2026	66 ABG/CEIEA	AFCEC	Medium	T&E	Management, Species	MXRDA53267119	Conduct avian point-count surveys to determine the presence and location of grasshopper sparrows, eastern meadowlarks, upland sandpipers, and sedge wrens (at HAFB) and golden-winged warblers (at Sagamore Hill). If present, develop future projects for management.
T & E Species, Species Mgt,	2	2.1	One time	2026	66 ABG/CEIEA	AFCEC	Low	T&E	Management, Species	MXRDA53267119	Conduct bridle shiner surveys in waterways and wetlands at HAFB and GSUs. If present, develop future projects for management.
T & E Species, Species Mgt, Habitat Mgt	2	2.5	Annual	2026	66 ABG/CEIEA	AFCEC	High	T&E	Management, Habitat	MXRDA53267118	Forth Cliff Blue Mussel restoration demonstration project
Wetland Mgt	4	4.1	One time	2026	66 ABG/CEIEA	AFCEC	High	WTLD	Management, Wetlands / Floodplains	MXRDA5326915	Golf course wetland rehabilitation, phase 3 (of 3)
Invasive Species Mgt	4	4.1	Annual	2026	66 ABG/CEIEA	AFCEC	High	INRP	Management, Invasive Species	MXRDA53266121	Annual invasive species control and eradication
Outreach	5	5.1; 5.2	Annual	2026	66 ABG/CEIEA	AFCEC	Low	MNRA	Outreach	MXRDA53268114	Public outreach and other public natural resources engagement and outreach supporting materials
Nuisance Species Mgt, T&E Species Mgt	6	6.1	Annual	2026	66 ABG/CEIEA	AFCEC	Medium	T&E	Management, Nuisance Wildlife	MXRDA53267122	Predation control at Fourth Cliff to protect ESA listed shorebird species
T & E Species, Species Mgt, Habitat Mgt	1	1.1	Annual	2027	66 ABG/CEIEA USFWS	AFCEC	High	INRP	Interagency/Intra-agency, Government, Sikes Act	MXRDA5327616	On site USFWS support
T & E Species, Species Mgt, Habitat Mgt	1	1.4	Annual	2027	66 ABG/CEIEA	AFCEC	High	T&E	Management, Habitat	MXRDA53277118	Conduct annual survey/analysis of shorebird habitat, including sediment transport, to monitor effects of erosion and erosion control project; necessary to determine if sediment supplementation is needed
T & E Species, Species Mgt, Habitat Mgt	2	2.1	Annual	2027	66 ABG/CEIEA	AFCEC	High	T&E	Management, Species	MXRDA53277119	Conduct shorebird surveys on the barrier beach at 4th Cliff to determine the location and recovery statistics of piping plovers; red knots; and least, common, and roseate terns.
T & E Species, Species Mgt,	2	2.2	Annual	2027	66 ABG/CEIEA	AFCEC	High	T&E	Management, Species	MXRDA53277119	Develop and manage species identified in the surveys conducted in preceding years
Invasive Species Mgt	4	4.1	Annual	2027	66 ABG/CEIEA	AFCEC	High	INRP	Management, Invasive Species	MXRDA53276121	Annual invasive species control and eradication
Outreach	5	5.1; 5.2	Annual	2027	66 ABG/CEIEA	AFCEC	Low	MNRA	Outreach	MXRDA53278114	Public outreach and other public natural resources engagement and outreach supporting materials
Nuisance Species Mgt, T&E Species Mgt	6	6.1	Annual	2027	66 ABG/CEIEA	AFCEC	Medium	T&E	Management, Nuisance Wildlife	MXRDA53277122	Predation control at Fourth Cliff to protect ESA listed shorebird species

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Table 10-2. *Natural Resources standard titles by PB28 code (excluding Environmental Technical Support/ Environmental Compliance Program Management Office titles).

INRP	MMA	T&E	MNRA	WTLD
P&F, CN	Mgt, Species	Mgt, Habitat	Compliance Public Notification	Mgt, Wetlands / FloodPlains Floodplains
Interagency/Intraagency, Government, Sikes Act	Interagency/Intraagency, Government, Sikes Act	Mgt, Species	Plan Update, Other	Monitor Wetlands
Interagency/Intraagency, Government, Sikes Act, CLEO	Outsourced Environmental Services, CN	Mgt, Invasive Species	Recordkeeping, Other	Interagency/Intraagency, Government, Sikes Act
Outsourced Environmental Services, CN	Supplies, CN	Mgt, Nuisance Wildlife	Outreach	Outsourced Environmental Services, CN
Supplies, CN	Supplies, CN, CLEO	Interagency/Intraagency, Government, Sikes Act		
Supplies, CN, CLEO	Vehicle Leasing, CN	Interagency/Intraagency, Government, Sikes Act, CLEO		
Equipment Purchase / Maintain, CN		Outsourced Environmental Services, CN		
Vehicle Leasing, CN		Supplies, CN		
Vehicle Fuel & Maintenance, CN		Supplies, CN, CLEO		
Mgt, Wildland Fire		Equipment Purchase / Maintain, CN		
Plan Update, INRMP		Vehicle Leasing, CN		
Plan Update, Other		Vehicle Fuel & Maintenance, CN		
Mgt, Habitat		Plan Update, Other		
Mgt, Species		Environmental Services, CN		
Mgt, Invasive Species				
Mgt, Nuisance Wildlife				
Recordkeeping, Other				
Environmental Services, CN				

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3731 **11.0 REFERENCES**

3732 **11.1 Standard References (Applicable to all USAF installations)**

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4617 **12.0 ACRONYMS AND ABBREVIATIONS**

4618 ***12.1 Standard Acronyms (Applicable to all USAF installations)***

- 4619 • [eDASH Acronym Library](#)
- 4620 • [Natural Resources Playbook – Acronym Section](#)
- 4621 • [U.S. EPA Terms & Acronyms](#)

4622 ***12.2 Installation Acronyms***

- 4623 • 3rd Cliff Third Cliff
- 4624 • 4th Cliff Fourth Cliff Recreation Annex
- 4625 • 66 ABG 66th Air Base Group
- 4626 • 66 ABG/CE 66th Air Base Group, Civil Engineer
- 4627 • 66 ABG/CEIE 66th Air Base Group, Civil Engineer Installation Management Flight,
4628 Environmental Element
- 4629 • 66 ABG/CEOH 66th Air Base Group, Civil Engineer, Operations Flight, Heavy Repair
4630 Element
- 4631 • 66 CED 66th Civil Engineering Division
- 4632 • 66 FSS 66th Force Support Squadron
- 4633 • AAC Adaptation Advisory Committee (for Climate Change)
- 4634 • ABG Air Base Group
- 4635 • AFB Air Force Base
- 4636 • AFI Air Force Instruction
- 4637 • AFLCMC Air Force Life Cycle Management Center
- 4638 • AFMAN Air Force Manual
- 4639 • AFMC Air Force Materiel Command
- 4640 • AFPD Air Force Policy Directive
- 4641 • BASH Bird/Wildlife Air Strike Hazard
- 4642 • BMP Best Management Practice
- 4643 • CATEX Categorical Exclusion
- 4644 • CE Civil Engineering
- 4645 • CECOS Civil Engineer Corps Officers School (Naval)
- 4646 • CFR Code of Federal Regulations
- 4647 • CLEO Conservation Law Enforcement Officer
- 4648 • CRBA Coastal Resources Barrier Act
- 4649 • CRM Cultural Resources Manager
- 4650 • DoD Department of Defense
- 4651 • DoDI Department of Defense Instruction
- 4652 • DRYDAYS Annual largest number of consecutive days with less than 1 millimeter of
4653 precipitation
- 4654 • EIAP Environmental Impact Analysis Process
- 4655 • EMP Environmental Management Practice
- 4656 • EO Executive Order
- 4657 • EOEEA Executive Office of Energy and Environmental Affairs (of Massachusetts)
- 4658 • ESA Endangered Species Act
- 4659 • ESC Electronics Systems Center

INTEGRATED NATURAL RESOURCE MANAGEMENT PLAN

4660	•	FASL	Feet Above Sea Level
4661	•	FC	Federal Candidate
4662	•	FE	Federally Endangered
4663	•	FT	Federally Threatened
4664	•	GDD	Average Annual Accumulated Growing Degree Days with a Base
4665			Temperature of 50 °F
4666	•	GIS	Geographic Information Systems
4667	•	GSU	Geographically Separated Unit
4668	•	HAFB	Hanscom Air Force Base
4669	•	HOTDAYS	Average number of hot days exceeding 90 °F
4670	•	IAW	In Accordance With
4671	•	ICRMP	Integrated Cultural Resources Management Plan
4672	•	IDP	Installation Development Plan
4673	•	INRMP	Integrated Natural Resources Management Plan
4674	•	IPCC	International Panel on Climate Change
4675	•	M.G.L.	Massachusetts General Law
4676	•	Mass Audubon	Massachusetts Audubon Society
4677	•	MassGIS	Massachusetts Bureau of Geographic Information
4678	•	Massport	Massachusetts Port Authority
4679	•	MassWildlife	Massachusetts Division of Fisheries and Wildlife
4680	•	MCZM	Massachusetts Office of Coastal Zone Management
4681	•	MEMA	Massachusetts Emergency Management Agency
4682	•	MESA	Massachusetts Endangered Species Act
4683	•	MIT	Massachusetts Institute of Technology
4684	•	NE CASC	Northeast Climate Adaptation Science Center
4685	•	NEPA	National Environmental Policy Act
4686	•	NHESP	Massachusetts Natural Heritage and Endangered Species Program
4687	•	NOAA Fisheries	National Marine Fisheries Service (of NOAA)
4688	•	NOAA	National Oceanic and Atmospheric Administration
4689	•	NRHP	National Register of Historic Places
4690	•	NRM	Natural Resources Manager
4691	•	PARC	Partners in Amphibian and Reptile Conservation
4692	•	P.L.	Public Law
4693	•	PMP	Pest Management Plan
4694	•	PRECIP	Average Annual Precipitation (inches)
4695	•	RCP	Representative Concentration Pathway
4696	•	Sagamore Hill	Sagamore Hill Solar Weather Observatory Annex
4697	•	SE	State Endangered
4698	•	SFHA	Special Flood Hazard Area
4699	•	SLR	Sea Level Rise
4700	•	SSC	Species of Special Concern
4701	•	ST	State Threatened
4702	•	T&E	Threatened and Endangered
4703	•	TAVE	Annual Average Temperature F°
4704	•	TMAX	Annual Average Maximum Temperature F°

INTEGRATED NATURAL RESOURCE MANAGEMENT PLAN

- 4705 • TMIN Annual Average Minimum Temperature F°
- 4706 • U.S. United States
- 4707 • USACE United States Army Corps of Engineers
- 4708 • USAF United States Air Force
- 4709 • U.S.C. United States Code
- 4710 • USEPA United States Environmental Protection Agency
- 4711 • USFWS United States Fish and Wildlife Service
- 4712 • WETDAYS Annual number of days with precipitation exceeding 2 inches in a day
- 4713

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4714 **13.0 DEFINITIONS**

4715 ***13.1 Standard Definitions (Applicable to all USAF installations)***

- 4716 • [Natural Resources Playbook – Definitions Section](#)

4717 ***13.2 Installation Definitions***

- 4718 • N/A

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4720 **14.0 APPENDICES**

4721 **14.1 Standard Appendices**

4722 *Appendix A. Annotated summary of key legislation related to design and implementation of the INRMP*

Table 14-1. Annotated summary of key legislation related to design and implementation of the INRMP.

Federal Public Laws and Executive Orders	
National Defense Authorization Act of 1989, Public Law (P.L.) 101-189; Volunteer Partnership Cost-Share Program	Amends two Acts and establishes volunteer and partnership programs for natural and cultural resources management on DoD lands.
Defense Appropriations Act of 1991, P.L. 101-511; Legacy Resource Management Program	Establishes the “Legacy Resource Management Program” for natural and cultural resources. Program emphasis is on inventory and stewardship responsibilities of biological, geophysical, cultural, and historic resources on DoD lands, including restoration of degraded or altered habitats.
EO 11514, Protection and Enhancement of Environmental Quality	Federal agencies shall initiate measures needed to direct their policies, plans, and programs to meet national environmental goals. They shall monitor, evaluate, and control agency activities to protect and enhance the quality of the environment.
EO 11593, Protection and Enhancement of the Cultural Environment	All Federal agencies are required to locate, identify, and record all cultural resources. Cultural resources include sites of archaeological, historical, or architectural significance.
EO 11988, Floodplain Management	Provides direction regarding actions of Federal agencies in floodplains, and requires permits from state, territory and Federal review agencies for any construction within a 100-year floodplain and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities for acquiring, managing and disposing of Federal lands and facilities.
EO 11989, Off-Road vehicles on Public Lands	Installations permitting off-road vehicles to designate and mark specific areas/trails to minimize damage and conflicts, publish information including maps, and monitor the effects of their use. Installations may close areas if adverse effects on natural, cultural, or historic resources are observed.
EO 11990, Protection of Wetlands	Requires Federal agencies to avoid undertaking or providing assistance for new construction in wetlands unless there is no practicable alternative, and all practicable measures to minimize harm to wetlands have been implemented and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for (1) acquiring, managing, and disposing of Federal lands and facilities; and (2) providing Federally undertaken, financed, or assisted construction and improvements; and (3) conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.

Table 14-1. Annotated summary of key legislation related to design and implementation of the INRMP.

EO 12088, Federal Compliance with Pollution Control Standards	This EO delegates responsibility to the head of each executive agency for ensuring all necessary actions are taken for the prevention, control, and abatement of environmental pollution. This order gives the U.S. Environmental Protection Agency (USEPA) authority to conduct reviews and inspections to monitor federal facility compliance with pollution control standards.
EO 12898, Environmental Justice	This EO requires certain federal agencies, including the DoD, to the greatest extent practicable permitted by law, to make environmental justice part of their missions by identifying and addressing disproportionately high and adverse health or environmental effects on minority and low-income populations.
EO 13112, Invasive Species	To prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause.
EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds	The USFWS has the responsibility to administer, oversee, and enforce the conservation provisions of the Migratory Bird Treaty Act, which includes responsibility for population management (e.g., monitoring), habitat protection (e.g., acquisition, enhancement, and modification), international coordination, and regulations development and enforcement.
EO 14008, <i>Tackling the Climate Crisis at Home and Abroad</i>	This EO required the Department of Defense to prioritize action on climate change in policy making and budget processes, in contracting and procurement, and in engagement with state, local, tribal, and territorial governments.
EO 14072, <i>Strengthening the Nation's Forests, Communities, and Local Economies</i>	This EO establishes policy to maintain, restore, and conserve the Nation's forests, to include old growth and mature forests, to limit international deforestation, and to combat climate change and enhance resilience.
United States Code	
Animal Damage Control Act (7 U.S.C. § 426-426b, 47 Stat. 1468)	Provides authority to the Secretary of Agriculture for investigation and control of mammalian predators, rodents, and birds. DoD installations may enter into cooperative agreements to conduct animal control projects.
Bald and Golden Eagle Protection Act of 1940, as amended; 16 U.S.C. 668-668c	This law provides for the protection of the bald eagle (the national emblem) and the golden eagle by prohibiting, except under certain specified conditions, the taking, possession and commerce of such birds. The 1972 amendments increased penalties for violating provisions of the Act or regulations issued pursuant thereto and strengthened other enforcement measures. Rewards are provided for information leading to arrest and conviction for violation of the Act.
Clean Air Act, (42 U.S.C. § 7401– 7671q, 14 July 1955, as amended)	This Act, as amended, is known as the Clean Air Act of 1970. The amendments made in 1970 established the core of the clean air program. The primary objective is to establish Federal standards for air pollutants. It is designed to improve air quality in areas of the country which do not meet federal standards and to prevent significant deterioration in areas where air quality exceeds those standards.

Table 14-1. Annotated summary of key legislation related to design and implementation of the INRMP.

<p>Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund) (26 U.S.C. § 4611–4682, P.L. 96-510, 94 Stat. 2797), as amended</p>	<p>Authorizes and administers a program to assess damage, respond to releases of hazardous substances, fund cleanup, establish clean-up standards, assign liability, and other efforts to address environmental contaminants. Installation Restoration Program guides cleanups at DoD installations.</p>
<p>Endangered Species Act (ESA) of 1973, as amended; P.L. 93-205, 16 U.S.C. § 1531 et seq.</p>	<p>Protects threatened, endangered, and candidate species of fish, wildlife, and plants and their designated critical habitats. Under this law, no federal action is allowed to jeopardize the continued existence of an endangered or threatened species. The ESA requires consultation with the USFWS and the NOAA Fisheries and the preparation of a biological evaluation or a biological assessment may be required when such species are present in an area affected by government activities.</p>
<p>Federal Aid in Wildlife Restoration Act of 1937 (16 U.S.C. § 669–669i; 50 Stat. 917) (Pittman-Robertson Act)</p>	<p>Provides federal aid to states and territories for management and restoration of wildlife. Fund derives from sports tax on arms and ammunition. Projects include acquisition of wildlife habitat, wildlife research surveys, development of access facilities, and hunter education.</p>
<p>Federal Environmental Pesticide Act of 1972</p>	<p>Requires installations to ensure pesticides are used only in accordance with their label registrations and restricted-use pesticides are applied only by certified applicators.</p>
<p>Federal Land Use Policy and Management Act, 43 U.S.C. § 1701–1782</p>	<p>Requires management of public lands to protect the quality of scientific, scenic, historical, ecological, environmental, and archaeological resources and values; and to preserve and protect certain lands in their natural condition for fish and wildlife habitat. This Act also requires consideration of commodity production such as timbering.</p>
<p>Federal Noxious Weed Act of 1974, 7 U.S.C. § 2801–2814</p>	<p>The Act provides for the control and management of non-indigenous weeds that injure or have the potential to injure the interests of agriculture and commerce, wildlife resources, or the public health.</p>
<p>Federal Water Pollution Control Act (Clean Water Act), 33 U.S.C. § 1251–1387</p>	<p>The Clean Water Act is a comprehensive statute aimed at restoring and maintaining the chemical, physical, and biological integrity of the nation’s waters. Primary authority for the implementation and enforcement rests with the USEPA.</p>
<p>Fish and Wildlife Conservation Act (16 U.S.C. § 2901–2911; 94 Stat. 1322, PL 96-366)</p>	<p>Installations encouraged to use their authority to conserve and promote conservation of nongame fish and wildlife in their habitats.</p>
<p>Fish and Wildlife Coordination Act (16 U.S.C. § 661 et seq.)</p>	<p>Directs installations to consult with the USFWS, or state or territorial agencies to ascertain means to protect fish and wildlife resources related to actions resulting in the control or structural modification of any natural stream or body of water. Includes provisions for mitigation and reporting.</p>
<p>Lacey Act of 1900 (16 U.S.C. § 701, 702, 32 Stat. 187, 32 Stat. 285)</p>	<p>Prohibits the importation of wild animals or birds or parts thereof, taken, possessed, or exported in violation of the laws of the country or territory of origin. Provides enforcement and penalties for violation of wildlife related Acts or regulations.</p>

Table 14-1. Annotated summary of key legislation related to design and implementation of the INRMP.

Leases: Non-excess Property of Military Departments, 10 U.S.C. § 2667, as amended	Authorizes DoD to lease to commercial enterprises Federal land not currently needed for public use. Covers agricultural outleasing program.
Migratory Bird Treaty Act 16 U.S.C. § 703–712	The Act implements various treaties for the protection of migratory birds. Under the Act, taking, killing, or possessing migratory birds is unlawful without a valid permit.
National Environmental Policy Act of 1969 (NEPA), as amended; P.L. 91-190, 42 U.S.C. § 4321 et seq.	Requires federal agencies to use a systematic approach when assessing environmental impacts of government activities. Establishes the use of environmental impact statements. NEPA proposes an interdisciplinary approach in a decision-making process designed to identify unacceptable or unnecessary impacts on the environment. The Council of Environmental Quality created Regulations for Implementing the National Environmental Policy Act [40 Code of Federal Regulations (CFR) Parts 1500– 1508], which provide regulations applicable to and binding on all Federal agencies for implementing the procedural provisions of NEPA, as amended.
National Historic Preservation Act, 16 U.S.C. § 470 et seq.	Requires federal agencies to take account of the effect of any federally assisted undertaking or licensing on any district, site, building, structure, or object included in or eligible for inclusion in the NRHP. Provides for the nomination, identification (through listing on the NRHP), and protection of historical and cultural properties of significance.
National Trails Systems Act (16 U.S.C. § 1241–1249)	Provides for the establishment of recreation and scenic trails.
National Wildlife Refuge Acts	Provides for establishment of National Wildlife Refuges through purchase, land transfer, donation, cooperative agreements, and other means.
National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd–668ee)	Provides guidelines and instructions for the administration of Wildlife Refuges and other conservation areas.
Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. § 3001–13; 104 Stat. 3042), as amended	Established requirements for the treatment of Native American human remains and sacred or cultural objects found on Federal lands. Includes requirements on inventory, and notification.
Rivers and Harbors Act of 1899 (33 U.S.C. § 401 et seq.)	Makes it unlawful for the USAF to conduct any work or activity in navigable waters of the United States without a federal permit. Installations should coordinate with the USACE to obtain permits for the discharge of refuse affecting navigable waters under National Pollutant Discharge Elimination System and should coordinate with the USFWS to review effects on fish and wildlife of work and activities to be undertaken as permitted by the USACE.
Sale of certain interests in land, 10 U.S.C. § 2665	Authorizes sale of forest products and reimbursement of the costs of management of forest resources.

Table 14-1. Annotated summary of key legislation related to design and implementation of the INRMP.

<p>Soil and Water Conservation Act (16 U.S.C. § 2001, P.L. 95-193)</p>	<p>Installations shall coordinate with the Secretary of Agriculture to appraise, on a continual basis, soil/water-related resources. Installations will develop and update a program for furthering the conservation, protection, and enhancement of these resources consistent with other federal and local programs.</p>
<p>Sikes Act (16 U.S.C. § 670a–670l, 74 Stat. 1052), as amended</p>	<p>Provides for the cooperation of DoD, the USFWS, and the State Fish and Game Department in planning, developing, and maintaining fish and wildlife resources on a military installation. Requires development of an INRMP and public access to natural resources and allows collection of nominal hunting and fishing fees. NOTE: AFMAN 32-7003 sec 3.11. INRMP Implementation. As defined in DoDI 4715.03, use professionally trained natural resources management personnel with a degree in the natural sciences to develop and implement the installation INRMP. (T-0). 3.9.1. Outsourcing Natural Resources Management. As stipulated in the Sikes Act, 16 U.S.C. § 670 et. seq., the Office of Management and Budget Circular No. A-76, Performance of Commercial Activities, August 4, 1983 (Revised May 29, 2003) does not apply to the development, implementation and enforcement of INRMPs. Activities that require the exercise of discretion in making decisions regarding the management and disposition of government owned natural resources are inherently governmental. When it is not practicable to use DoD personnel to perform inherently governmental natural resources management duties, obtain these services from federal agencies having responsibilities for the conservation and management of natural resources.</p>
<p>DoD Policy, Directives, and Instructions</p>	
<p>DoD Instruction 4150.07 DoD Pest Management Program dated 29 May 2008</p>	<p>Implements policy, assigns responsibilities, and prescribes procedures for the DoD Integrated Pest Management Program.</p>
<p>DoD Instruction 4150.07 <i>DoD Pest Management Program</i>, 29 May 2008</p>	<p>Implements policy, assigns responsibilities, and prescribes procedures for the DoD Integrated Pest Management Program.</p>
<p>DoD Instruction 4715.1, <i>Environmental Security</i></p>	<p>Establishes policy for protecting, preserving, and (when required) restoring and enhancing the quality of the environment. This instruction also ensures environmental factors are integrated into DoD decision-making processes that could impact the environment, and are given appropriate consideration along with other relevant factors.</p>
<p>DoD Instruction (DoDI) 4715.03, Natural Resources Conservation Program</p>	<p>Implements policy, assigns responsibility, and prescribes procedures under DoDI 4715.1 for the integrated management of natural and cultural resources on property under DoD control.</p>

Table 14-1. Annotated summary of key legislation related to design and implementation of the INRMP.

<p>Office of the Secretary of Defense Policy Memorandum , 17 May 2005, Implementation of Sikes Act Improvement Amendments: Supplemental Guidance Concerning Leased Lands</p>	<p>Provides supplemental guidance for implementing the requirements of the Sikes Act in a consistent manner throughout DoD. The guidance covers lands occupied by tenants or lessees or being used by others pursuant to a permit, license, right of way, or any other form of permission. INRMPs must address the resource management on all lands for which the subject installation has real property accountability, including leased lands. Installation commanders may require tenants to accept responsibility for performing appropriate natural resource management actions as a condition of their occupancy or use, but this does not preclude the requirement to address the natural resource management needs of these lands in the installation INRMP.</p>
<p>Office of the Secretary of Defense Policy Memorandum – 1 November 2004 – Implementation of Sikes Act Improvement Act Amendments: Supplemental Guidance Concerning INRMP Reviews</p>	<p>Emphasizes implementing and improving the overall INRMP coordination process. Provides policy on scope of INRMP review, and public comment on INRMP review.</p>
<p>Office of the Secretary of Defense Policy Memorandum – 10 October 2002, <i>Implementation of Sikes Act Improvement Act: Updated Guidance</i></p>	<p>Provides guidance for implementing the requirements of the Sikes Act in a consistent manner throughout DoD and replaces the 21 September 1998 guidance Implementation of the Sikes Act Improvement Amendments. Emphasizes implementing and improving the overall INRMP coordination process and focuses on coordinating with stakeholders, reporting requirements and metrics, budgeting for INRMP projects, using the INRMP as a substitute for critical habitat designation, supporting military training and testing needs, and facilitating the INRMP review process.</p>
<p>USAF Instructions and Directives</p>	
<p>AFI 32-1015, <i>Integrated Installation Planning</i> and 32 CFR Part 898, as amended</p>	<p>This publication establishes a comprehensive and integrated planning framework for development/redevelopment of Air Force installations. Provides guidance and responsibilities in the EIAP for implementing INRMPs. Implementation of an INRMP constitutes a major federal action and therefore is subject to evaluation through an Environmental Assessment or an Environmental Impact Statement.</p>
<p>AFMAN 32-7003, Environmental Conservation</p>	<p>Implements AFD 32-70, <i>Environmental Considerations in Air Force Programs and Activities</i>. It also requires that INRMP preparation and revision shall follow the ecosystem management principles and guidelines in DoDI 4715.03, <i>Natural Resources Conservation Program</i>; supports AFI 32-7001, <i>Environmental Management</i>; and provides guidance and procedures for natural and cultural resources programs at USAF installations.</p>

Table 14-1. Annotated summary of key legislation related to design and implementation of the INRMP.

<p>AFMAN 32-7003, Environmental Conservation</p>	<p>This Manual implements AFPD 32-70 and DoDI 4710.1, <i>Archaeological and Historic Resources Management</i>. It explains how to manage cultural resources on USAF property in compliance with Federal, state, territorial, and local standards.</p>
<p>AFI 32-10112 Installation Geospatial Information and Services</p>	<p>This instruction implements Department of Defense Instruction (DoDI) 8130.01, Installation Geospatial Information and Services by identifying the requirements to implement and maintain a USAF Installation Geospatial Information and Services program and AFPD 32-10 Installations and Facilities.</p>
<p>AFPD 32-70, Environmental Considerations in Air Force Programs and Activities, 30 July 2018 (supersedes 32-70, Environmental Quality, 20 July 1994)</p>	<p>Establishes USAF need for a systematic approach to and framework for environmental management. Implements a broad range of DoDIs and Directives pertaining to natural resources management, including environmental conservation, compliance, health and safety, restoration/remediation, waste and contaminants, assessments, and interactions with indigenous people/lands. Outlines the USAF mission to achieve and maintain environmental quality on all USAF lands by cleaning up environmental damage resulting from past activities, meeting all environmental regulations and standards applicable to present operations, planning future activities to minimize environmental impacts, responsibly managing the irreplaceable natural and cultural resources held in public trust, and eliminating pollution production wherever possible. AFPD 32-70 also establishes policies to carry out these objectives.</p>
<p>Policy Memo for Implementation of Sikes Act Improvement Amendments, Headquarters USAF Environmental Office, 29 January 1999</p>	<p>Outlines the USAF interpretation and explanation of the Sikes Act and Improvement Act of 1997.</p>

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4724 **14.2 Installation Appendices**

4725 *14.2.1 Appendix B. Lists of species known or expected to occur at Hanscom Air Force Base and its*
4726 *geographically separated units.*

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Table 14-2. Animal species documented on and/or adjacent to Hanscom Air Force Base.

Species	Scientific Name	Listing Status ¹	Source*
Mammals			
Short tailed shrew	<i>Blarina brevicauda</i>	—	LEC Environmental Consultants, Inc. 1999
Eastern coyote	<i>Canis latrans</i>	—	CEMML 2022b
Boreal Redback Vole	<i>Clethrionomys gapperi</i>	—	LEC Environmental Consultants, Inc. 1999
Least Shrew	<i>Cryptotis parva</i>	—	LEC Environmental Consultants, Inc. 1999
Virginia opossum	<i>Didelphis virginiana</i>	—	LEC Environmental Consultants, Inc. 1999, CEMML 2022b
Big brown bat	<i>Eptesicus fuscus</i>	—	Massport 2019
Silver-haired bat	<i>Lasionycteris noctivagans</i>	—	Schwab 2018
Eastern red bat	<i>Lasiurus borealis</i>	—	Schwab 2018
Hoary bat	<i>Lasiurus cinereus</i>	—	Schwab 2018
Bobcat	<i>Lynx rufus</i>	—	CEMML 2022b
Groundhog	<i>Marmota monax</i>	—	CEMML 2022b
Striped Skunk	<i>Mephitis mephitis</i>	—	Massport 2019
Meadow vole	<i>Microtus pennsylvanicus</i>	—	LEC Environmental Consultants, Inc. 1999
Voles	<i>Microtus spp.</i>	—	LEC Environmental Consultants, Inc. 1999
Little brown bat	<i>Myotis lucifugus</i>	SE	Schwab 2018
White-tailed deer	<i>Odocoileus virginianus</i>	—	CEMML 2022b
Canyon bat	<i>Parastrellus hesperus</i>	—	Schwab 2018
Raccoon	<i>Procyon lotor</i>	—	CEMML 2022b
Eastern gray squirrel	<i>Sciurus carolinensis</i>	—	CEMML 2022b
Rabbit	<i>Sylvilagus sp.</i>	—	CEMML 2022b
Eastern chipmunk	<i>Tamias striatus</i>	—	CEMML 2022b
Gray fox	<i>Urocyon cinereoargenteus</i>	—	CEMML 2022b
Red fox	<i>Vulpes Vulpes</i>	—	CEMML 2022b
Deer mouse	<i>Peromyscus maniculatus</i>	—	LEC Environmental Consultants, Inc. 1999
White footed mouse	<i>Peromyscus leucopus</i>	—	LEC Environmental Consultants, Inc. 1999
Birds			
Hawk	<i>Accipiter sp.</i>	—	Massport 2019
Red-winged blackbird	<i>Agelaius phoeniceus</i>	—	LEC Environmental Consultants, Inc. 1999
Grasshopper sparrow	<i>Ammodramus savannarum</i>	ST	HAFB 2010a
Mallard	<i>Anas platyrhynchos</i>	—	LEC Environmental Consultants, Inc. 1999
Black duck	<i>Anas rubripes</i>	—	Massport 2019

Table 14-2. Animal species documented on and/or adjacent to Hanscom Air Force Base.

Species	Scientific Name	Listing Status ¹	Source*
Ducks	Anatidae (family)	—	Massport 2019
American pipit	<i>Anthus rubescens</i>	—	Massport 2019
Great blue heron	<i>Ardea herodias</i>	—	LEC Environmental Consultants, Inc. 1999
Upland sandpiper	<i>Bartramia longicauda</i>	SE	HAFB 2010a
Cedar waxwing	<i>Bombycilla cedrorum</i>	—	LEC Environmental Consultants, Inc. 1999
Canada Goose	<i>Branta canadensis</i>	—	LEC Environmental Consultants, Inc. 1999
Snowy owl	<i>Bubo scandiacus</i>	—	Massport 2019
Great horned-owl	<i>Bubo virginianus</i>	—	Massport 2019
Red-tailed hawk	<i>Buteo jamaicensis</i>	—	LEC Environmental Consultants, Inc. 1999
Hawk	<i>Buteo sp.</i>	—	Massport 2019
Red-shouldered hawk	<i>Buteo lineatus</i>	—	LEC Environmental Consultants, Inc. 1999
Least sandpiper	<i>Calidris minutilla</i>	—	Massport 2019
Northern cardinal	<i>Cardinalis cardinalis</i>	—	LEC Environmental Consultants, Inc. 1999
American goldfinch	<i>Carduelis tristis</i>	—	LEC Environmental Consultants, Inc. 1999
Eastern purple finch	<i>Carpodacus purpureus</i>	—	LEC Environmental Consultants, Inc. 1999
Turkey vulture	<i>Cathartes aura</i>	—	Massport 2019
Swainson's Swainson's thrush	<i>Catharus ustulatus</i>	—	Massport 2019
Chimney swift	<i>Chaetura pelagica</i>	—	Massport 2019
Semi-palmated plover	<i>Charadrius semipalmatus</i>	—	Massport 2019
Killdeer	<i>Charadrius vociferus</i>	—	LEC Environmental Consultants, Inc. 1999
Common nighthawk	<i>Chordeiles minor</i>	—	LEC Environmental Consultants, Inc. 1999
Northern Flicker	<i>Colaptes auratus</i>	—	LEC Environmental Consultants, Inc. 1999
Domestic pigeon	<i>Columba livia</i>	—	LEC Environmental Consultants, Inc. 1999
American crow	<i>Corvus brachyrhynchos</i>	—	LEC Environmental Consultants, Inc. 1999
Blue Jay	<i>Cyanocitta cristata</i>	—	LEC Environmental Consultants, Inc. 1999
Yellow warbler	<i>Dendroica petechia</i>	—	LEC Environmental Consultants, Inc. 1999
Hairy woodpecker	<i>Dendrocopos villosus</i>	—	LEC Environmental Consultants, Inc. 1999

Table 14-2. Animal species documented on and/or adjacent to Hanscom Air Force Base.

Species	Scientific Name	Listing Status ¹	Source*
Bobolink	<i>Dolichonyx oryzivorus</i>	—	Massport 2019
Gray catbird	<i>Dumetella carolinensis</i>	—	LEC Environmental Consultants, Inc. 1999
Least flycatcher	<i>Empidonax alnorum</i>	—	LEC Environmental Consultants, Inc. 1999
Horned lark	<i>Eremophila alpestris</i>	—	Massport 2019
Peregrine falcon	<i>Falco peregrinus</i>	SSC	Massport 2019
American kestrel	<i>Falco sparverius</i>	—	LEC Environmental Consultants, Inc. 1999
House finch	<i>Haemorhous mexicanus</i>	—	LEC Environmental Consultants, Inc. 1999
Swallow sp.	Hirundinidae (family)	—	Massport 2019
Barn Swallow	<i>Hirundo rustica</i>	—	LEC Environmental Consultants, Inc. 1999
Wood thrush	<i>Hylocichla mustelina</i>	—	LEC Environmental Consultants, Inc. 1999
Baltimore Oriole	<i>Icterus galbula</i>	—	LEC Environmental Consultants, Inc. 1999
Dark-eyed junco	<i>Junco hyemalis</i>	—	Massport 2019
Slate-colored junco	<i>Junco hyernalis</i>	—	LEC Environmental Consultants, Inc. 1999
Gulls	Laridae (family)	—	Massport 2019
Herring gull	<i>Larus argentatus</i>	—	Massport 2019
Ring-billed gull	<i>Larus delawarensis</i>	—	Massport 2019
Short-billed Dowitcher	<i>Limnodromus griseus</i>	—	Massport 2019
Eastern wild turkey	<i>Meleagris gallopavo silvestris</i>	—	CEMML 2022b
Budgerigar	<i>Melopsittacus undulatus</i>	—	Massport 2019
Swamp sparrow	<i>Melospiza georgiana</i>	—	LEC Environmental Consultants, Inc. 1999
Song sparrow	<i>Melospiza melodia</i>	—	LEC Environmental Consultants, Inc. 1999
Northern mockingbird	<i>Mimus polyglottos</i>	—	LEC Environmental Consultants, Inc. 1999
Black-and-White Warbler	<i>Mniotilta varia</i>	—	LEC Environmental Consultants, Inc. 1999
Brown-headed Cowbird	<i>Molothrus ater</i>	—	LEC Environmental Consultants, Inc. 1999
Black-capped ChikadeeChickadee	<i>Parus atricapillus</i>	—	LEC Environmental Consultants, Inc. 1999
Tufted titmouse	<i>Parus bicolor</i>	—	LEC Environmental Consultants, Inc. 1999
English house sparrow	<i>Passer domesticus</i>	—	LEC Environmental Consultants, Inc. 1999

Table 14-2. Animal species documented on and/or adjacent to Hanscom Air Force Base.

Species	Scientific Name	Listing Status ¹	Source*
Savannah sparrow	<i>Passerculus sandwichensis</i>	—	Massport 2019
Ring-necked pheasant	<i>Phasianus colchicus</i>	—	LEC Environmental Consultants, Inc. 1999
Downy woodpecker	<i>Picoides pubescens</i>	—	LEC Environmental Consultants, Inc. 1999
Rufous-sided towhee	<i>Pipilo fuscus</i>	—	LEC Environmental Consultants, Inc. 1999
Snow bunting	<i>Plectrophenax nivalis</i>	—	Massport 2019
Black-bellied Plover	<i>Pluvialis squatarola</i>	—	Massport 2019
Blue-gray Gnatcatcher	<i>Polioptila caerulea</i>	—	LEC Environmental Consultants, Inc. 1999
Vesper sparrow	<i>Pooectes grimneus</i>	—	LEC Environmental Consultants, Inc. 1999
American golden-plover	<i>Pluvialis dominica</i>	—	Massport 2019
Common grackle	<i>Quiscalus quiscula</i>	—	LEC Environmental Consultants, Inc. 1999
Eastern phoebe	<i>Sayornis phoebe</i>	—	LEC Environmental Consultants, Inc. 1999
American woodcock	<i>Scolopax minor</i>	—	LEC Environmental Consultants, Inc. 1999
Prairie warbler	<i>Setophaga discolor</i>	—	Massport 2019
Blackpoll warbler	<i>Setophaga striata</i>	SSC	Massport 2019
Eastern bluebird	<i>Sialia Sialis</i>	—	Massport 2019
White-breasted nuthatch	<i>Sitta carolinensis</i>	—	LEC Environmental Consultants, Inc. 1999
Chirping sparrow	<i>Spizella passerina</i>	—	LEC Environmental Consultants, Inc. 1999
Field sparrow	<i>Spizella pusilla</i>	—	Massport 2019
Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	—	LEC Environmental Consultants, Inc. 1999
Barred owl	<i>Strix varia</i>	—	CEMML 2022b
Eastern meadowlark	<i>Sturnella magna</i>	SSC	Massport 2019
Starling	<i>Sturnus vulgaris</i>	—	LEC Environmental Consultants, Inc. 1999
Tree swallow	<i>Tachycineta bicolor</i>	—	Massport 2019
Brown thrasher	<i>Toxostoma rufum</i>	—	LEC Environmental Consultants, Inc. 1999
House wren	<i>Troglodytes aedon</i>	—	LEC Environmental Consultants, Inc. 1999
American robin	<i>Turdus migratorius</i>	—	LEC Environmental Consultants, Inc. 1999
Eastern kingbird	<i>Tyrannus tyrannus</i>	—	LEC Environmental Consultants, Inc. 1999

Table 14-2. Animal species documented on and/or adjacent to Hanscom Air Force Base.

Species	Scientific Name	Listing Status ¹	Source*
Blue-winged Warbler	<i>Vermivora cyanoptera</i>	—	LEC Environmental Consultants, Inc. 1999, Massport 2019
Red-eyed vireo	<i>Vireo olivaceus</i>	—	LEC Environmental Consultants, Inc. 1999
Wilson's warbler	<i>Wilsonia pusilla</i>	—	LEC Environmental Consultants, Inc. 1999
Mourning dove	<i>Zenaida macroura</i>	—	LEC Environmental Consultants, Inc. 1999
<i>Reptiles</i>			
Snapping turtle	<i>Chelydra serpentina</i>	—	LEC Environmental Consultants, Inc. 1999
<u>Wood turtle</u>	<u><i>Glyptemys insculpta</i></u>	<u>SSC</u>	<u>PARC 2019</u>
Spotted turtle	<i>Clemmys guttata</i>	—	HAFB 2010a
Blanding's turtle	<i>Emydoidea blandingii</i>	ST	Massport 2019
<i>Amphibians</i>			
Blue-spotted salamander	<i>Ambystoma laterale</i>	SSC	CEMML 2022b
Spotted salamander	<i>Ambystoma maculatum</i>	—	LEC Environmental Consultants, Inc. 1999
American toad	<i>Bufo americanus</i>	—	LEC Environmental Consultants, Inc. 1999
Mole salamander	Caudata: <i>Ambystoma</i>	—	LEC Environmental Consultants, Inc. 1999
Dusky Salamander	Caudata: <i>Desmognathus</i>	—	LEC Environmental Consultants, Inc. 1999
Red spotted newt	<i>Notophthalmus viridescens</i>	—	LEC Environmental Consultants, Inc. 1999
Spring peeper	<i>Pseudacris crucifer</i>	—	LEC Environmental Consultants, Inc. 1999
Bullfrog	<i>Rana catesbeiana</i>	—	LEC Environmental Consultants, Inc. 1999
Green frog	<i>Rana clamitans</i>	—	LEC Environmental Consultants, Inc. 1999
Wood frog	<i>Rana sylvatica</i>	—	LEC Environmental Consultants, Inc. 1999
<i>Fish</i>			
Banded Sunfish	<i>Enneacanthus obesus</i>	—	LEC Environmental Consultants, Inc. 1999
Redfin pickerel	<i>Esox americanus</i>	—	LEC Environmental Consultants, Inc. 1999
Brown bullhead	<i>Ictalurus melas</i>	—	LEC Environmental Consultants, Inc. 1999
Golden shiner	<i>Notemigonus crysoleucas</i>	—	LEC Environmental Consultants, Inc. 1999
<i>Invertebrates</i>			

Table 14-2. Animal species documented on and/or adjacent to Hanscom Air Force Base.

Species	Scientific Name	Listing Status ¹	Source*
Amphipod Shrimp	Amphipoda: Crangonycitidae	—	LEC Environmental Consultants, Inc. 1999
Fairy shrimp	Anostraca: Chirocephalidae	—	LEC Environmental Consultants, Inc. 1999
Fishing spider	Aranea: Lycosidae	—	LEC Environmental Consultants, Inc. 1999
Rusty crawfish	Cambaridae	—	LEC Environmental Consultants, Inc. 1999
Predaceous diving beetle	Coleoptera: Dytiscidae	—	LEC Environmental Consultants, Inc. 1999
Whirligig beetle	Coleoptera: Gyrinidae	—	LEC Environmental Consultants, Inc. 1999
Crawling water beetle	Coleoptera: Haliplidae	—	LEC Environmental Consultants, Inc. 1999
Water scavenger beetle	Coleoptera: Hydrophilidae	—	LEC Environmental Consultants, Inc. 1999
Eastern longhorn elderberry beetle	<i>Desmocerus palliatus</i>	—	LEC Environmental Consultants, Inc. 1999
Midge	Diptera: Chironomidae	—	LEC Environmental Consultants, Inc. 1999
Mosquito	Diptera: Culicidae	—	LEC Environmental Consultants, Inc. 1999
Phantom crane fly	Diptera: Ptychopteridae	—	LEC Environmental Consultants, Inc. 1999
Marsh fly	Diptera: Sciomyzidae	—	LEC Environmental Consultants, Inc. 1999
Horsefly	Diptera: Tabanidae	—	LEC Environmental Consultants, Inc. 1999
Pond snail	Gastropoda: Lymnaeidae	—	LEC Environmental Consultants, Inc. 1999
Flat spired snail	Gastropoda: Planorbidae	—	LEC Environmental Consultants, Inc. 1999
American medicinal leech	Gnathobdellida: Hirundinidae	—	LEC Environmental Consultants, Inc. 1999
Tube dwelling worm	Haplotaxida: Tubificidae	—	LEC Environmental Consultants, Inc. 1999
Giant Waterbug	Hemiptera: Belostomatidae	—	LEC Environmental Consultants, Inc. 1999
Water boatman	Hemiptera: Coroxidae	—	LEC Environmental Consultants, Inc. 1999
Water striders	Hemiptera: Gerridae	—	LEC Environmental Consultants, Inc. 1999
Backswimmer	Hemiptera: Notonectidae	—	LEC Environmental Consultants, Inc. 1999
Red water mite	Hydracarina	—	LEC Environmental Consultants, Inc. 1999

Table 14-2. Animal species documented on and/or adjacent to Hanscom Air Force Base.

Species	Scientific Name	Listing Status ¹	Source*
Sowbug	Isopoda: Asellidae	—	LEC Environmental Consultants, Inc. 1999
Aquatic Pyralid Moth	Lepidoptera: Pyralidae	—	LEC Environmental Consultants, Inc. 1999
Sowbug	Malacostraca: Asellidae	—	LEC Environmental Consultants, Inc. 1999
Fish fly	Megaloptera: Corydalidae	—	LEC Environmental Consultants, Inc. 1999
Sialus	Megaloptera: Sialidae	—	LEC Environmental Consultants, Inc. 1999
Snail	Mollusca: Gastropoda	—	LEC Environmental Consultants, Inc. 1999
Aquatic Nematode	Nematoda	—	LEC Environmental Consultants, Inc. 1999
Fish fly	Neuroptera: Corydalidae	—	LEC Environmental Consultants, Inc. 1999
Darner damselfly	Odonata: Aeshnidae	—	LEC Environmental Consultants, Inc. 1999
Damselfly	Odonata: Coenagrionidae	—	LEC Environmental Consultants, Inc. 1999
Violet dancer fly	Odonata: Coenagrionidae	—	LEC Environmental Consultants, Inc. 1999
Spread-winged damselfly	Odonata: Lestidae	—	LEC Environmental Consultants, Inc. 1999
Dragonfly	Odonata: Libellulidae	—	LEC Environmental Consultants, Inc. 1999
Green jacket dragonfly	Odonata: Libellulidae	—	LEC Environmental Consultants, Inc. 1999
Painted Skimmer Dragonfly	Odonata: Libellulidae	—	LEC Environmental Consultants, Inc. 1999
Ten-spot skimmer damselfly	Odonata: Libellulidae	—	LEC Environmental Consultants, Inc. 1999
White tailed skimmer damselfly	Odonata: Libellulidae	—	LEC Environmental Consultants, Inc. 1999
White-face skimmer damselfly	Odonata: Libellulidae	—	LEC Environmental Consultants, Inc. 1999
Fingernail vlam	Pelecypoda: Pisisdiidae	—	LEC Environmental Consultants, Inc. 1999
Northern casemakers	Trichoptera: Limnephilidae	—	LEC Environmental Consultants, Inc. 1999
Pond dwelling caddisfly	Trichoptera: Limnephilidae	—	LEC Environmental Consultants, Inc. 1999
Planarian Worm	Tricladida: Planariidae	—	LEC Environmental Consultants, Inc. 1999

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¹ FC = federal candidate for listing, FE = federal endangered, FT = federal threatened, SE = state endangered, ST = state threatened, SSC = state species of special concern, — = no listing status.

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- * Massport 2019 species are adjacent to Hanscom Air Force Base; these species have not been confirmed on the installation.

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Table 14-3. Animal species documented on and/or adjacent to Fourth Cliff.

Species	Scientific Name	Listing Status ¹	Source
Mammals			
Sei whale	<i>Balaenoptera borealis</i>	FE, SE	LEC Environmental Consultants, Inc. 2008a
Finback whale	<i>Balaenoptera physalus</i>	FE, SE	LEC Environmental Consultants, Inc. 2008a
Blue whale	<i>Balanoptera musculus</i>	FE, SE	LEC Environmental Consultants, Inc. 2008a
Virginia opossum	<i>Didelphis virginiana</i>	—	Lelito Environmental Consultants 1993
North Atlantic right whale	<i>Eubalaena glacialis</i>	FE, SE	LEC Environmental Consultants, Inc. 2008a, HAFB 2019b
Humpback whale	<i>Megaptera novaeangliae</i>	SE	LEC Environmental Consultants, Inc. 2008a
Striped skunk	<i>Mephitis mephitis</i>	—	Metcalf and Eddy AECOM 2009
Small dune mouse	<i>Microtus pennsylvanicus</i>	—	Lelito Environmental Consultants 1993
Harbor seal	<i>Phoca vitulina</i>	—	Lelito Environmental Consultants 1993
Sperm whale	<i>Physeter catodon</i>	FE, SE	LEC Environmental Consultants, Inc. 2008a
Raccoon	<i>Procyon lotor</i>	—	LEC Environmental Consultants, Inc. 2008a
Eastern cottontail rabbit	<i>Sylvilagus floridanus</i>	—	LEC Environmental Consultants, Inc. 2008a
Birds			
Spotted Sandpiper	<i>Actitis macularius</i>	—	Levasseur and MacCallum 2015
Red-winged blackbird	<i>Agelaius phoeniceus</i>	—	Lelito Environmental Consultants 1993
Mallard	<i>Anas platyrhynchos</i>	—	HAFB 2014
Black duck	<i>Anas rubripes</i>	—	HAFB 2014
Great egret	<i>Ardea alba</i>	—	HAFB 2014
Great blue heron	<i>Ardea herodias</i>	—	Lelito Environmental Consultants 1993
Ruddy Turnstone	<i>Arenaria interpres</i>	—	Levasseur and MacCallum 2015
Brant	<i>Branta spp.</i>	—	Lelito Environmental Consultants 1993
Snowy owl	<i>Bubo scandiacus</i>	—	Lelito Environmental Consultants 1993
Sanderling	<i>Calidris alba</i>	—	Levasseur and MacCallum 2015
Dunlin	<i>Calidris alpina</i>	—	Levasseur and MacCallum 2015
Red knot	<i>Calidris canutus rufa</i>	FT, ST	Levasseur and MacCallum 2015, Jorgenson et al. 2019
White-rumped Sandpiper	<i>Calidris fuscicollis</i>	—	Levasseur and MacCallum 2015
Western Sandpiper	<i>Calidris mauri</i>	—	Levasseur and MacCallum 2015
Least sandpiper	<i>Calidris minutilla</i>	—	Levasseur and MacCallum 2015
Semipalmated sandpiper	<i>Calidris pusilla</i>	—	Levasseur and MacCallum 2015
Sandpiper	<i>Calidris spp.</i>	—	Lelito Environmental Consultants 1993
Belted kingfisher	<i>Ceryle alcyon</i>	—	Lelito Environmental Consultants 1993
Piping plover	<i>Charadrius melodus</i>	FT, ST	Levasseur and MacCallum 2015
Semipalmated plover	<i>Charadrius semipalmatus</i>	—	Levasseur and MacCallum 2015
Killdeer	<i>Charadrius vociferus</i>	—	Levasseur and MacCallum 2015
Bufflehead	<i>Charitonetta albeola</i>	—	LEC Environmental Consultants, Inc. 2008a
Rock pigeon	<i>Columba livia</i>	—	HAFB 2014
American crow	<i>Corvus brachyrhynchos</i>	—	HAFB 2014

Table 14-3. Animal species documented on and/or adjacent to Fourth Cliff.

Species	Scientific Name	Listing Status ¹	Source
Common tern	Sterna hirundo	SSC	HAFB 2010a
Gray catbird	<i>Dumetella carolinensis</i>	—	LEC Environmental Consultants, Inc. 2008a
Little egret	<i>Egretta garzetta</i>	—	Metcalf and Eddy AECOM 2009
Peeps	<i>Ereunetes pusillus</i>	—	Lelito Environmental Consultants 1993
Merlin	<i>Falco columbarius</i>	—	Lelito Environmental Consultants 1993
Peregrine falcon	<i>Falco peregrinus</i>	SSC	Lelito Environmental Consultants 1993
Gallinules	<i>Gallinula spp.</i>	—	Lelito Environmental Consultants 1993
Common loon	<i>Gavia immer</i>	SSC	Lelito Environmental Consultants 1993
House finch	<i>Haemorhous mexicanus</i>	—	LEC Environmental Consultants, Inc. 2008a
Old-squaw cormorant	<i>Harelda hyemalis</i>	—	LEC Environmental Consultants, Inc. 2008a
Short-billed Dowitcher	<i>Limnodromus griseus</i>	—	Levasseur and MacCallum 2015
White-winged scoter	<i>Melanitta fusca</i>	—	Lelito Environmental Consultants 1993
Black scoter	<i>Melanitta nigra</i>	—	Lelito Environmental Consultants 1993
Surf scoter	<i>Melanitta perspicillata</i>	—	Lelito Environmental Consultants 1993
Scooter	<i>Melanitta spp.</i>	—	Metcalf and Eddy AECOM 2009
Whimbrel	<i>Numenius phaeopus</i>	—	Levasseur and MacCallum 2015
Osprey	<i>Pandion haliaetus carolinensis</i>	—	Lelito Environmental Consultants 1993
Cormorant	<i>Phalacrocorax carbo</i>	—	Metcalf and Eddy AECOM 2009
Snow bunting	<i>Plectrophenax nivalis</i>	—	LEC Environmental Consultants, Inc. 2008a
Black-bellied Plover	<i>Pluvialis squatarola</i>	—	Levasseur and MacCallum 2015
Grackle	<i>Quiscalus quiscula</i>	—	LEC Environmental Consultants, Inc. 2008a
Ruby crowned kinglet	<i>Regulus calendula</i>	—	Lelito Environmental Consultants 1993
Bank swallow	<i>Riparia riparia</i>	—	Lelito Environmental Consultants 1993
Red breasted nuthatch	<i>Sitta canadensis</i>	—	Lelito Environmental Consultants 1993
Eider	<i>Somateria dresseri</i>	—	LEC Environmental Consultants, Inc. 2008a
Roseate turn	<i>Sterna dougallii dougallii</i>	FE, SE	HAFB 2019c
Least tern	<i>Sternula antillarum</i>	SSC	Lelito Environmental Consultants 1993
Starling	<i>Sturnus vulgaris</i>	—	Lelito Environmental Consultants 1993
Greater Yellowlegs	<i>Tringa melanoleuca</i>	—	Levasseur and MacCallum 2015
Willet	<i>Tringa semipalmata</i>	—	Levasseur and MacCallum 2015
American robin	<i>Turdus migratorius</i>	—	LEC Environmental Consultants, Inc. 2008a
Mourning dove	<i>Zenaida macroura carolinensis</i>	—	Lelito Environmental Consultants 1993
Reptiles			
Loggerhead turtle	<i>Caretta caretta</i>	FT, ST	LEC Environmental Consultants, Inc. 2008a
Green turtle	<i>Chelonia mydas</i>	FT, ST	LEC Environmental Consultants, Inc. 2008a
Leatherback turtle	<i>Dermochelys coriacea</i>	FE, SE	LEC Environmental Consultants, Inc. 2008a
Atlantic Ridley	<i>Lepidochelys kempii</i>	FE, SE	LEC Environmental Consultants, Inc. 2008a
Fish			

Table 14-3. Animal species documented on and/or adjacent to Fourth Cliff.

Species	Scientific Name	Listing Status ¹	Source
Atlantic sturgeon	<i>Acipenser oxyrinchus</i>	FE, SE	HAFB 2019b
Shad	<i>Alosa sapidissima</i>	—	Lelito Environmental Consultants 1993
Hickory shad	<i>Alosa sp.</i>	—	Lelito Environmental Consultants 1993
American sand lance	<i>Ammodytes americanus</i>	—	Lelito Environmental Consultants 1993
Sand lance	<i>Ammodytes</i> sp.	—	Lelito Environmental Consultants 1993
American eel	<i>Anguilla rostrata</i>	—	Lelito Environmental Consultants 1993
Fourspine stickleback	<i>Apeltes quadracus</i>	—	Lelito Environmental Consultants 1993
Lumpfish	<i>Cyclopterus lumpus</i>	—	Lelito Environmental Consultants 1993
Mummichog	<i>Fundulus heteroclitus</i>	—	Lelito Environmental Consultants 1993
Striped killi fish	<i>Fundulus majalis</i>	—	Lelito Environmental Consultants 1993
Cod	<i>Gadus morhua</i>	—	Lelito Environmental Consultants 1993
Threespine stickleback	<i>Gasterosteus aculeatus</i>	ST	Lelito Environmental Consultants 1993
Sea raven	<i>Hemitripterus americanus</i>	—	Lelito Environmental Consultants 1993
Atlantic silversides	<i>Menidia menidia</i>	—	Lelito Environmental Consultants 1993
Atlantic tomcod	<i>Microgadus tomcod</i>	—	LEC Environmental Consultants, Inc. 2008a
Ocean sunfish	<i>Mola mola</i>	—	Lelito Environmental Consultants 1993
Longhorn sculpin	<i>Myoxocephalus octodecemspinosus</i>	—	Lelito Environmental Consultants 1993
Coho salmon	<i>Oncorhynchus kisutch</i>	—	LEC Environmental Consultants, Inc. 2008a
Smelt	<i>Osmerus mordax</i>	—	Lelito Environmental Consultants 1993
Pollock	<i>Pollachius virens</i>	—	Lelito Environmental Consultants 1993
Bluefish	<i>Pomatomus saltatrix</i>	—	Lelito Environmental Consultants 1993
Alewife	<i>Pomolobus pseudoharengus</i>	—	Lelito Environmental Consultants 1993
Herring	<i>Pomolobus spp.</i>	—	LEC Environmental Consultants, Inc. 2008a
Winter flounder	<i>Pseudopleuronectes americanus</i>	—	Lelito Environmental Consultants 1993
Smelt flounder	<i>Pseudopleuronectes sp.</i>	—	Lelito Environmental Consultants 1993
Skate	<i>Raja spp.</i>	—	Lelito Environmental Consultants 1993
Striped bass	<i>Roccus saxatilis</i>	—	Lelito Environmental Consultants 1993
Atlantic salmon	<i>Salmo salar</i>	—	HAFB 2019b
Brown trout	<i>Salmo trutta</i>	—	LEC Environmental Consultants, Inc. 2008a
Brook trout	<i>Salvelinus fontinalis</i>	—	Lelito Environmental Consultants 1993
Windowpane flounders	<i>Scophthalmus aquosus</i>	—	Lelito Environmental Consultants 1993
Northern pipefish	<i>syngnathus fuscus</i>	—	Lelito Environmental Consultants 1993
Cunner	<i>Tautoglabrus adspersus</i>	—	LEC Environmental Consultants, Inc. 2008a
White hake	<i>Urophycis tenuis</i>	—	Lelito Environmental Consultants 1993
Invertebrates			
Ocean quahog	<i>Arctica islandica</i>	—	LEC Environmental Consultants, Inc. 2008a
Bay scallop	<i>Argopecten irradians</i>	—	LEC Environmental Consultants, Inc. 2008a

Table 14-3. Animal species documented on and/or adjacent to Fourth Cliff.

Species	Scientific Name	Listing Status ¹	Source
Starfish	<i>Asterias spp.</i>	—	Lelito Environmental Consultants 1993
Barnacle	<i>Balanus spp.</i>	—	LEC Environmental Consultants, Inc. 2008a
Rock crab	<i>Cancer irroratus</i>	—	LEC Environmental Consultants, Inc. 2008a
Green crab	<i>Carcinides maenas</i>	—	LEC Environmental Consultants, Inc. 2008a
Sand shrimp	<i>Crangon septemspinus</i>	—	Lelito Environmental Consultants 1993
Oyster	<i>Crassostrea virginica</i>	—	HAFB 2014
Sand dollar	<i>Echinarachnius parma</i>	—	Lelito Environmental Consultants 1993
Razor clam	<i>Ensis directus</i>	—	HAFB 2014
Ribbed muscles	<i>Geukensia demissa</i>	—	HAFB 2014
Lobster	<i>Homarus americanus</i>	—	Lelito Environmental Consultants 1993
Quahog	<i>Mercenaria mercenaria</i>	—	LEC Environmental Consultants, Inc. 2008a
Soft shell clam	<i>Mya arenaria</i>	—	HAFB 2014
Blue mussel	<i>Mytilus edulis</i>	—	LEC Environmental Consultants, Inc. 2008a
Sea worms	<i>Nereis virens</i>	—	Lelito Environmental Consultants 1993
Hermit crab	<i>Pagurus pollicaris</i>	—	Lelito Environmental Consultants 1993
Sea scallop	<i>Placopecten magellanicus</i>	—	LEC Environmental Consultants, Inc. 2008a
Sea clam	<i>Spisula solidissima</i>	—	LEC Environmental Consultants, Inc. 2008a
Fiddler crab	<i>Uca sp.</i>	—	HAFB 2014

4734 ¹FC = federal candidate for listing, FE = federal endangered, FT = federal threatened, SE = state endangered, ST =
 4735 state threatened, SSC = state species of special concern, — = no listing status.
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Table 14-4. Animal species documented on Sagamore Hill.

Species	Scientific Name	Listing Status ¹	Source
Mammals			
Short-tailed shrew	<i>Blarina brevicauda</i>	—	LEC Environmental Consultants, Inc. 2008b
Eastern coyote	<i>Canis latrans</i>	—	CEMML 2022b
Virginia opossum	<i>Didelphis virginiana</i>	—	CEMML 2022b
Big brown bat	<i>Eptesicus fuscus</i>	—	Schwab 2018
Flying squirrel	<i>Glaucomys sp.</i>	—	CEMML 2022b
Silver-haired bat	<i>Lasionycteris noctivagans</i>	—	Schwab 2018
Groundhog	<i>Marmota monax</i>	—	CEMML 2022b
Fisher	<i>Martes pennanti</i>	—	LEC Environmental Consultants, Inc. 2008b
Striped Skunk	<i>Mephitis mephitis</i>	—	CEMML 2022b
Little brown bat	<i>Myotis lucifugus</i>	SE	Schwab 2018
Northern long-eared bat	<i>Myotis septentrionalis</i>	FT, SE	Schwab 2018
White-tailed deer	<i>Odocoileus virginianus</i>	—	CEMML 2022b
Tricolored bat	<i>Perimyotis subflavus</i>	SE	Schwab 2018
Raccoon	<i>Procyon lotor</i>	—	CEMML 2022b
Eastern gray squirrel	<i>Sciurus carolinensis</i>	—	CEMML 2022b
Rabbit	<i>Sylvilagus sp.</i>	—	CEMML 2022b
New England cottontail rabbit	<i>Sylvilagus transitionalis</i>	—	LEC Environmental Consultants, Inc. 2008b
Eastern chipmunk	<i>Tamias striatus</i>	—	CEMML 2022b
Gray fox	<i>Urocyon cinereoargenteus</i>	—	CEMML 2022b
Red fox	<i>Vulpes Vulpes</i>	—	CEMML 2022b
Birds			
Ruffed grouse	<i>Bonasa umbellus</i>	—	LEC Environmental Consultants, Inc. 2008b
Red-shouldered hawk	<i>Buteo lineatus</i>	—	LEC Environmental Consultants, Inc. 2008b
Broad-winged hawk	<i>Buteo platypterus</i>	—	LEC Environmental Consultants, Inc. 2008b
Purple finch	<i>Carpodacus purpureus</i>	—	LEC Environmental Consultants, Inc. 2008b
American crow	<i>Corvus brachyrhynchos</i>	—	LEC Environmental Consultants, Inc. 2008b
Common yellowthroat	<i>Geothlypis trichas</i>	—	LEC Environmental Consultants, Inc. 2008b
Eastern wild turkey	<i>Meleagris gallopavo silvestris</i>	—	CEMML 2022b
Rose-breasted grosbeak	<i>Pheucticus ludovicianus</i>	—	LEC Environmental Consultants, Inc. 2008b
Eastern towhee	<i>Pipilo erythrophthalmus</i>	—	LEC Environmental Consultants, Inc. 2008b

Table 14-4. Animal species documented on Sagamore Hill.

Species	Scientific Name	Listing Status ¹	Source
Eastern phoebe	<i>Sayornis phoebe</i>	—	LEC Environmental Consultants, Inc. 2008b
Amphibians			
Fowler's toad	<i>Bufo woodhousii fowleri</i>	—	LEC Environmental Consultants, Inc. 2008b

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¹ FC = federal candidate for listing, FE = federal endangered, FT = federal threatened, SE = state endangered, ST = state threatened, SSC = state species of special concern, — = no listing status.

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Table 14-5. Vegetation species documented on Hanscom Air Force Base.

Species	Scientific Name	Listing Status ¹	Source
<i>Trees, Shrubs, and Vines</i>			
Norway maple	<i>Acer platanoides</i>	—	LEC Environmental Consultants, Inc. 1999
Red maple	<i>Acer rubrum</i>	—	LEC Environmental Consultants, Inc. 1999
Speckled alder	<i>Alnus rugosa</i>	—	LEC Environmental Consultants, Inc. 1999
Shadbush	<i>Amelanchier sanguinea</i>	SSC	LEC Environmental Consultants, Inc. 1999
Chokeberry	<i>Aronia</i> sp.	—	LEC Environmental Consultants, Inc. 1999
Japanese barberry	<i>Berberis thunbergii</i>	—	LEC Environmental Consultants, Inc. 1999
Yellow birch	<i>Betula alleghaniensis</i>	—	LEC Environmental Consultants, Inc. 1999
Black birch	<i>Betula lenta</i>	—	LEC Environmental Consultants, Inc. 1999
Paper birch	<i>Betula papyrifera</i>	—	LEC Environmental Consultants, Inc. 1999
Gray birch	<i>Betula populifolia</i>	—	LEC Environmental Consultants, Inc. 1999
Ironwood	<i>Carpinus caroliniana</i>	—	LEC Environmental Consultants, Inc. 1999
Sweet pignut hickory	<i>Carya glabra</i>	—	LEC Environmental Consultants, Inc. 1999
Shag-bark hickory	<i>Carya ovata</i>	—	LEC Environmental Consultants, Inc. 1999
Catalpa	<i>Catalpa speciosa</i>	—	LEC Environmental Consultants, Inc. 1999
American bittersweet	<i>Celastrus scandens</i>	ST	LEC Environmental Consultants, Inc. 1999
Sweet pepperbush	<i>Clethra alnifolia</i>	—	LEC Environmental Consultants, Inc. 1999
Silky dogwood	<i>Cornus amomum</i>	—	LEC Environmental Consultants, Inc. 1999
Beaked hazelnut	<i>Corylus cornuta</i>	—	LEC Environmental Consultants, Inc. 2007
Hawthorn	<i>Crataegus</i> sp.	—	LEC Environmental Consultants, Inc. 2007
Burning bush	<i>Euonymus atropurpureus</i>	—	LEC Environmental Consultants, Inc. 2007
American beech	<i>Fagus grandifolia</i>	—	LEC Environmental Consultants, Inc. 1999
Forsythia	<i>Forsythia viridissima</i>	—	LEC Environmental Consultants, Inc. 1999
Green ash	<i>Fraxinus pennsylvanica</i>	—	LEC Environmental Consultants, Inc. 2007
Huckleberry	<i>Gaylussacia</i> sp.	—	LEC Environmental Consultants, Inc. 1999
Witch-hazel	<i>Hamamelis virginiana</i>	—	LEC Environmental Consultants, Inc. 1999

Table 14-5. Vegetation species documented on Hanscom Air Force Base.

Species	Scientific Name	Listing Status ¹	Source
Common winterberry holly	<i>Ilex verticillata</i>	—	LEC Environmental Consultants, Inc. 1999
Eastern red cedar	<i>Juniperus virginiana</i>	—	LEC Environmental Consultants, Inc. 1999
Sheep laurel	<i>Kalmia angustifolia</i>	—	LEC Environmental Consultants, Inc. 1999
Spicebush	<i>Lindera benzoin</i>	—	LEC Environmental Consultants, Inc. 1999
Honeysuckle	<i>Lonicera</i> spp.	—	LEC Environmental Consultants, Inc. 1999
Tartarian honeysuckle	<i>Lonicera tatarica</i>	—	LEC Environmental Consultants, Inc. 1999
Tupelo	<i>Nyssa sylvatica</i>	—	LEC Environmental Consultants, Inc. 1999
Red pine	<i>Pinus resinosa</i>	—	LEC Environmental Consultants, Inc. 1999
Eastern white pine	<i>Pinus strobus</i>	—	LEC Environmental Consultants, Inc. 1999
Eastern cottonwood	<i>Populus deltoides</i>	—	LEC Environmental Consultants, Inc. 1999
Big-tooth poplar	<i>Populus grandidentata</i>	—	LEC Environmental Consultants, Inc. 1999
Quaking aspen	<i>Populus tremuloides</i>	—	LEC Environmental Consultants, Inc. 1999
Pin cherry	<i>Prunus pensylvanica</i>	—	LEC Environmental Consultants, Inc. 1999
Peach	<i>Prunus persica</i>	—	LEC Environmental Consultants, Inc. 1999
Black Cherry	<i>Prunus serotina</i>	—	LEC Environmental Consultants, Inc. 1999
Wafer ash	<i>Ptelea trifoliata</i>	—	LEC Environmental Consultants, Inc. 1999
Swamp white oak	<i>Quercus bicolor</i>	—	LEC Environmental Consultants, Inc. 1999
Scarlet oak	<i>Quercus coccinea</i>	—	LEC Environmental Consultants, Inc. 1999
Northern red oak	<i>Quercus rubra</i>	—	LEC Environmental Consultants, Inc. 1999
Common buckthorn	<i>Rhamnus cathartica</i>	—	LEC Environmental Consultants, Inc. 2007
European buckthorn	<i>Rhamnus frangula</i>	—	LEC Environmental Consultants, Inc. 1999
Swamp azalea	<i>Rhododendron viscosum</i>	—	LEC Environmental Consultants, Inc. 1999
Staghorn Sumac	<i>Rhus typhina</i>	—	LEC Environmental Consultants, Inc. 1999
Currant	<i>Ribes</i> spp.	—	LEC Environmental Consultants, Inc. 2007
Black Locust	<i>Robinia pseudoacacia</i>	—	LEC Environmental Consultants, Inc. 1999
Multiflora rose	<i>Rosa multiflora</i>	—	LEC Environmental Consultants, Inc. 1999

Table 14-5. Vegetation species documented on Hanscom Air Force Base.

Species	Scientific Name	Listing Status ¹	Source
Allegheny blackberry	<i>Rubus allegheniensis</i>	—	LEC Environmental Consultants, Inc. 1999
Prickly dewberry	<i>Rubus flagellaris</i>	—	LEC Environmental Consultants, Inc. 1999
Common red raspberry	<i>Rubus idaeus</i>	—	LEC Environmental Consultants, Inc. 1999
Weeping willow	<i>Salix babylonica</i>	—	LEC Environmental Consultants, Inc. 1999
Pussy willow	<i>Salix discolor</i>	—	LEC Environmental Consultants, Inc. 1999
Black Willow	<i>Salix nigra</i>	—	LEC Environmental Consultants, Inc. 1999
Common elderberry	<i>Sambucus canadensis</i>	—	LEC Environmental Consultants, Inc. 1999
Sassafras	<i>Sassafras albidum</i>	—	LEC Environmental Consultants, Inc. 1999
Common greenbrier	<i>Smilax rotundifolia</i>	—	LEC Environmental Consultants, Inc. 1999
Meadowsweet	<i>Spiraea latifolia</i>	—	LEC Environmental Consultants, Inc. 1999
Steeple bush	<i>Spiraea tomentosa</i>	—	LEC Environmental Consultants, Inc. 1999
American yew	<i>Taxus canadensis</i>	—	LEC Environmental Consultants, Inc. 1999
Cedar	<i>Thuja</i> sp.	—	LEC Environmental Consultants, Inc. 2007
Poison ivy	<i>Toxicodendron radicans</i>	—	LEC Environmental Consultants, Inc. 1999
Eastern hemlock	<i>Tsuga canadensis</i>	—	LEC Environmental Consultants, Inc. 1999
American elm	<i>Ulmus americana</i>	—	LEC Environmental Consultants, Inc. 1999
Slippery elm	<i>Ulmus rubra</i>	—	LEC Environmental Consultants, Inc. 1999
Lowbush blueberry	<i>Vaccinium angustifolium</i>	—	LEC Environmental Consultants, Inc. 1999
Highbush blueberry	<i>Vaccinium corymbosum</i>	—	LEC Environmental Consultants, Inc. 1999
Wild raisin	<i>Viburnum cassinoides</i>	—	LEC Environmental Consultants, Inc. 1999
Nannyberry	<i>Viburnum lentago</i>	—	LEC Environmental Consultants, Inc. 1999
Northern arrowwood	<i>Viburnum recognitum</i>	—	LEC Environmental Consultants, Inc. 1999
Grapevine	<i>Vitis</i> spp.	—	LEC Environmental Consultants, Inc. 1999
<i>Herbaceous</i>			
Yarrow	<i>Achillea millefolium</i>	—	LEC Environmental Consultants, Inc. 1999
Bent grass	<i>Agrostis</i> sp.	—	LEC Environmental Consultants, Inc. 1999

Table 14-5. Vegetation species documented on Hanscom Air Force Base.

Species	Scientific Name	Listing Status ¹	Source
Red top	<i>Agrostis alba</i>	—	LEC Environmental Consultants, Inc. 1999
Garlic mustard	<i>Alliaria petiolata</i>	—	LEC Environmental Consultants, Inc. 1999
Bluestem	<i>Andropogon</i> sp.	—	LEC Environmental Consultants, Inc. 1999
Broomsedge	<i>Andropogon virginicus</i>	—	LEC Environmental Consultants, Inc. 1999
Great burdock	<i>Arctium lappa</i>	—	LEC Environmental Consultants, Inc. 1999
Swamp milkweed	<i>Asclepias incarnata</i>	—	LEC Environmental Consultants, Inc. 2007
Milkweed	<i>Asclepias</i> sp.	—	LEC Environmental Consultants, Inc. 1999
Swamp aster	<i>Aster puniceus</i>	—	LEC Environmental Consultants, Inc. 1999
Aster	<i>Aster</i> sp.	—	LEC Environmental Consultants, Inc. 1999
Yellow rocket	<i>Barbarea vulgaris</i>	—	LEC Environmental Consultants, Inc. 1999
Swamp beggar ticks	<i>Bidens connata</i>	—	LEC Environmental Consultants, Inc. 1999
Devil's beggar ticks	<i>Bidens frondosa</i>	—	LEC Environmental Consultants, Inc. 1999
Cut-leaf grapefern	<i>Botrychium dissectum</i>	—	LEC Environmental Consultants, Inc. 1999
Tussock sedge	<i>Carex stricta</i>	—	LEC Environmental Consultants, Inc. 1999
Blue-Joint Reedgrass	<i>Calamagrostis canadensis</i>	—	LEC Environmental Consultants, Inc. 1999
Reedgrass	<i>Calamagrostis</i> sp.	—	LEC Environmental Consultants, Inc. 1999
Water starwort	<i>Callitriche stagnalis</i>	—	LEC Environmental Consultants, Inc. 1999
Marsh marigold	<i>Caltha palustris</i>	—	LEC Environmental Consultants, Inc. 1999
Fringed sedge	<i>Carex crinita</i>	—	LEC Environmental Consultants, Inc. 2007
Sedge	<i>Carex</i> sp.	—	LEC Environmental Consultants, Inc. 1999
Star thistle	<i>Centaurea</i> sp.	—	LEC Environmental Consultants, Inc. 1999
Buttonbush	<i>Cephalanthus occidentalis</i>	—	LEC Environmental Consultants, Inc. 2007
Common mullein	<i>Cerbascum thapsus</i>	—	LEC Environmental Consultants, Inc. 1999
Celeandine	<i>Chelidonium majus</i>	—	LEC Environmental Consultants, Inc. 1999
Virginia's virgins-bower	<i>Clematis virginiana</i>	—	LEC Environmental Consultants, Inc. 2007
Sweet fern	<i>Comptonia peregrina</i>	—	LEC Environmental Consultants, Inc. 1999

Table 14-5. Vegetation species documented on Hanscom Air Force Base.

Species	Scientific Name	Listing Status ¹	Source
Goldthread	<i>Coptis trifolia</i>	—	LEC Environmental Consultants, Inc. 1999
Strawcolored nutsedge	<i>Cyperus strigosus</i>	—	LEC Environmental Consultants, Inc. 1999
Pink lady slipper	<i>Cypripedium acaule</i>	—	LEC Environmental Consultants, Inc. 1999
Deer tongue	<i>Dichanthelium clandestinum</i>	—	LEC Environmental Consultants, Inc. 2007
Crested shield-fern	<i>Dryopteris cristata</i>	—	LEC Environmental Consultants, Inc. 1999
Spinulose woodfern	<i>Dryopteris spinulosa</i>	—	LEC Environmental Consultants, Inc. 1999
American waterwort	<i>Elatine americana</i>	SE	LEC Environmental Consultants, Inc. 2007
Beech drop	<i>Epifagus virginiana</i>	—	LEC Environmental Consultants, Inc. 1999
Trailing arbutus	<i>Epigaea repens</i>	—	LEC Environmental Consultants, Inc. 1999
Horsetail	<i>Equisetum</i> sp.	—	LEC Environmental Consultants, Inc. 1999
Daisy fleabane	<i>Erigeron annuus</i>	—	LEC Environmental Consultants, Inc. 2007
Spotted Joe-Pye weed	<i>Eupatorium maculatum</i>	—	LEC Environmental Consultants, Inc. 2007
Catchweed bedstraw	<i>Galium aparine</i>	—	LEC Environmental Consultants, Inc. 1999
Bedstraw	<i>Gallium</i> sp.	—	LEC Environmental Consultants, Inc. 1999
American wintergreen	<i>Gaultheria procumbens</i>	—	LEC Environmental Consultants, Inc. 1999
Canadian St. John's wort	<i>Hypericum canadensis</i>	—	LEC Environmental Consultants, Inc. 1999
Jewelweed	<i>Impatiens capensis</i>	—	LEC Environmental Consultants, Inc. 1999
Iris	<i>Iris</i> sp.	—	LEC Environmental Consultants, Inc. 1999
Blueflag iris	<i>Iris versicolor</i>	—	LEC Environmental Consultants, Inc. 2007
Canada rush	<i>Juncus canadensis</i>	—	LEC Environmental Consultants, Inc. 1999
Soft rush	<i>Juncus effusus</i>	—	LEC Environmental Consultants, Inc. 1999
Path rush	<i>Juncus tenuis</i>	—	LEC Environmental Consultants, Inc. 2007
Peppergrass	<i>Lepidium</i> sp.	—	LEC Environmental Consultants, Inc. 1999
Flax	<i>Linum</i> sp.	—	LEC Environmental Consultants, Inc. 1999
Rye grass	<i>Lolium perenne</i>	—	LEC Environmental Consultants, Inc. 1999
Tree clubmoss	<i>Lycopodium obscurum</i>	—	LEC Environmental Consultants, Inc. 1999

Table 14-5. Vegetation species documented on Hanscom Air Force Base.

Species	Scientific Name	Listing Status ¹	Source
Water-horehound	<i>Lycopus virginicus</i>	—	LEC Environmental Consultants, Inc. 1999
Whorled loosestrife	<i>Lysimachia quadrifolia</i>	—	LEC Environmental Consultants, Inc. 1999
Purple loosestrife	<i>Lythrum salicaria</i>	—	LEC Environmental Consultants, Inc. 1999
Canada mayflower	<i>Maianthemum canadense</i>	—	LEC Environmental Consultants, Inc. 1999
Indian cucumber root	<i>Medeola virginiana</i>	—	LEC Environmental Consultants, Inc. 2007
Field mint	<i>Mentha arvensis</i>	—	LEC Environmental Consultants, Inc. 1999
Partridge berry	<i>Mitchella repens</i>	—	LEC Environmental Consultants, Inc. 1999
Common evening primrose	<i>Oenothera biennis</i>	—	LEC Environmental Consultants, Inc. 1999
Sensitive Fern	<i>Onoclea sensibilis</i>	—	LEC Environmental Consultants, Inc. 1999
One-flower Broom-rape	<i>Orobanche uniflora</i>	—	LEC Environmental Consultants, Inc. 1999
Cinnamon Fern	<i>Osmunda cinnamomea</i>	—	LEC Environmental Consultants, Inc. 1999
Interrupted Interrupted fern	<i>Osmunda claytonia</i>	—	LEC Environmental Consultants, Inc. 2007
Royal fern	<i>Osmunda regalis</i>	—	LEC Environmental Consultants, Inc. 1999
Wood sorrel	<i>Oxalis montana</i>	—	LEC Environmental Consultants, Inc. 2007
Reed canary grass	<i>Phalaris arundinacea</i>	—	LEC Environmental Consultants, Inc. 1999
Common reed	<i>Phragmites australis</i>	—	LEC Environmental Consultants, Inc. 2007
Pokeweed	<i>Phytolacca americana</i>	—	LEC Environmental Consultants, Inc. 1999
Solomon's seal	<i>Polygonatum</i> sp.	—	LEC Environmental Consultants, Inc. 1999
Halberd-leaf tear thumb	<i>Polygonum arifolium</i>	—	LEC Environmental Consultants, Inc. 1999
Mild water pepper	<i>Polygonum hydropiperoides</i>	—	LEC Environmental Consultants, Inc. 1999
Knotweeds	<i>Polygonum</i> sp.	—	LEC Environmental Consultants, Inc. 1999
Bracken Fern	<i>Pteridium aquilinum</i>	—	LEC Environmental Consultants, Inc. 1999
Shinleaf	<i>Pyrola elliptica</i>	—	LEC Environmental Consultants, Inc. 2007
Wintergreen	<i>Pyrola virens</i>	—	LEC Environmental Consultants, Inc. 1999
Swamp buttercup	<i>Ranunculus septentrionalis</i>	—	LEC Environmental Consultants, Inc. 2007
Buttercup	<i>Ranunculus</i> sp.	—	LEC Environmental Consultants, Inc. 1999

Table 14-5. Vegetation species documented on Hanscom Air Force Base.

Species	Scientific Name	Listing Status ¹	Source
Bristly Dewberry	<i>Rubus hispidus</i>	—	LEC Environmental Consultants, Inc. 1999
Woolgrass	<i>Scirpus cyperinus</i>	—	LEC Environmental Consultants, Inc. 1999
Smooth carrion flower	<i>Smilax herbacea</i>	—	LEC Environmental Consultants, Inc. 1999
Bittersweet nightshade	<i>Solanum dulcamara</i>	—	LEC Environmental Consultants, Inc. 2007
Black Nightshade	<i>Solanum nigrum</i>	—	LEC Environmental Consultants, Inc. 1999
Canada goldenrod	<i>Solidago canadensis</i>	—	LEC Environmental Consultants, Inc. 2007
Goldenrod	<i>Solidago</i> spp.	—	LEC Environmental Consultants, Inc. 1999
Slender-leaf goldenrod	<i>Solidago tenuifolia</i>	—	LEC Environmental Consultants, Inc. 1999
American burreed	<i>Sparganium americanum</i>	—	LEC Environmental Consultants, Inc. 1999
Sphagnum moss	<i>Sphagnum</i> sp.	—	LEC Environmental Consultants, Inc. 1999
Mosses	<i>Sphagnum</i> sp.	—	LEC Environmental Consultants, Inc. 1999
Celandine poppy	<i>Stylophorum diphyllum</i>	—	LEC Environmental Consultants, Inc. 2007
Skunk cabbage	<i>Symplocarpus foetidus</i>	—	LEC Environmental Consultants, Inc. 1999
Common dandelion	<i>Taraxacum officinale</i>	—	LEC Environmental Consultants, Inc. 1999
Purple meadow rue	<i>Thalictrum dasycarpum</i>	—	LEC Environmental Consultants, Inc. 2007
New York fern	<i>Thelypteris noveboracensis</i>	—	LEC Environmental Consultants, Inc. 2007
Massachusetts fern	<i>Thelypteris simulata</i>	—	LEC Environmental Consultants, Inc. 1999
Clover	<i>Trifolium</i> sp.	—	LEC Environmental Consultants, Inc. 1999
White trillium	<i>Trillium grandiflorum</i>	—	LEC Environmental Consultants, Inc. 2007
Common cattail	<i>Typha latifolia</i>	—	LEC Environmental Consultants, Inc. 1999
Stinging nettle	<i>Urtica dioica</i>	—	LEC Environmental Consultants, Inc. 1999
Blue vervain	<i>Verbena hastata</i>	—	LEC Environmental Consultants, Inc. 1999
Common vetch	<i>Vicia sativa</i>	—	LEC Environmental Consultants, Inc. 1999
Violet	<i>Viola</i> sp.	—	LEC Environmental Consultants, Inc. 1999

¹ FC = federal candidate for listing, FE = federal endangered, FT = federal threatened, SE = state endangered, ST = state threatened, SSC = state species of special concern, — = no listing status.

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Table 14-6. Vegetation species documented on Fourth Cliff.

Species	Scientific Name	Listing Status ¹	Source
<i>Trees, Shrubs, and Vines</i>			
Shadbush	<i>Amelanchier arborea</i>	—	LEC Environmental Consultants, Inc. 2008a
False indigo	<i>Amorpha fruticosa</i>	—	LEC Environmental Consultants, Inc. 2008a
American bittersweet	<i>Celastrus scandens</i>	ST	LEC Environmental Consultants, Inc. 2008a
Bull thistle	<i>Cirsium vulgare</i>	—	LEC Environmental Consultants, Inc. 2008a
Marsh elder	<i>Iva frutescens</i>	—	Metcalf and Eddy AECOM 2009
Eastern red cedar	<i>Juniperus virginiana</i>	—	LEC Environmental Consultants, Inc. 2008a
Privet	<i>Ligustrum vulgare</i>	—	LEC Environmental Consultants, Inc. 2008a
Tartarian honeysuckle	<i>Lonicera tatarica</i>	—	HAFB 2014
Bayberry	<i>Myrica pensylvanica</i>	—	LEC Environmental Consultants, Inc. 2008a
Scotch pine	<i>Pinus sylvestris</i>	—	LEC Environmental Consultants, Inc. 2008a
Beach plum	<i>Prunus maritima</i>	—	LEC Environmental Consultants, Inc. 2008a
Black Cherry	<i>Prunus serotina</i>	—	LEC Environmental Consultants, Inc. 2008a
Northern red oak	<i>Quercus rubra</i>	—	LEC Environmental Consultants, Inc. 2008a
Staghorn sumac	<i>Rhus typhina</i>	—	LEC Environmental Consultants, Inc. 2008a
Pasture Rose	<i>Rosa carolina</i>	—	LEC Environmental Consultants, Inc. 2008a
Multiflora rose	<i>Rosa multiflora</i>	—	LEC Environmental Consultants, Inc. 2008a
Ruga rose	<i>Rosa rugosa</i>	—	LEC Environmental Consultants, Inc. 2008a
Dewberry	<i>Rubus</i> sp.	—	LEC Environmental Consultants, Inc. 2008a
Elderberry	<i>Sambucus dulcamara</i>	—	LEC Environmental Consultants, Inc. 2008a
<i>Herbaceous</i>			
Yarrow	<i>Achillea millefolium</i>	—	LEC Environmental Consultants, Inc. 2008a
Quackgrass	<i>Agropyron repens</i>	—	Lelito Environmental Consultants 1993
Beachgrass	<i>Ammophila breviligulata</i>	—	Lelito Environmental Consultants 1993
Milkweed	<i>Asclepias</i> sp.	—	LEC Environmental Consultants, Inc. 2008a
Orchard grass	<i>Dactylis glomerata</i>	—	LEC Environmental Consultants, Inc. 2008a
Queen Anne's lace	<i>Daucus carota</i>	—	LEC Environmental Consultants, Inc. 2008a
Salt grass	<i>Distichlis spicata</i>	—	Metcalf and Eddy AECOM 2009
Terrell grass	<i>Elymus virginicus</i>	—	Lelito Environmental Consultants 1993
Hawkweed	<i>Hieracium pratense</i>	—	Lelito Environmental Consultants 1993
Beach heather	<i>Hudsonia tomentosa</i>	—	Lelito Environmental Consultants 1993
Beach pea	<i>Lathyrus japonicus</i>	—	Lelito Environmental Consultants 1993
Sea lavender	<i>Limonium nashii</i>	—	Lelito Environmental Consultants 1993
Common evening primrose	<i>Oenothera biennis</i>	—	LEC Environmental Consultants, Inc. 2008a
Pokeweed	<i>Phytolacca americana</i>	—	LEC Environmental Consultants, Inc. 2008a
Evening primrose	<i>Primula laurentiana</i>	—	LEC Environmental Consultants, Inc. 2008a
Seashore alkali grass	<i>Puccinellia maritima</i>	—	Lelito Environmental Consultants 1993
Blackberry	<i>Rubus</i> sp.	—	LEC Environmental Consultants, Inc. 2008a

Table 14-6. Vegetation species documented on Fourth Cliff.

Species	Scientific Name	Listing Status ¹	Source
Curly dock	<i>Rumex crispus</i>	—	LEC Environmental Consultants, Inc. 2008a
Salt worts	<i>Salicornia</i> spp.	—	Lelito Environmental Consultants 1993
Seaside golden-rod	<i>Solidago sempervirens</i>	—	Lelito Environmental Consultants 1993
Goldenrod	<i>Solidago</i> spp.	—	LEC Environmental Consultants, Inc. 2008a
Saltmarsh cordgrass	<i>Spartina alterniflora</i>	—	Lelito Environmental Consultants 1993
Salt meadow cordgrass	<i>Spartina patens</i>	—	HAFB 2014
Tansy	<i>Tanacetum vulgare</i>	—	Lelito Environmental Consultants 1993
Poison ivy	<i>Toxicodendron radicans</i>	—	LEC Environmental Consultants, Inc. 2008a
Arrowwood	<i>Viburnum dentatum</i>	—	LEC Environmental Consultants, Inc. 2008a
Grapevine	<i>Vitis</i> spp.	—	LEC Environmental Consultants, Inc. 2008a

¹FC = federal candidate for listing, FE = federal endangered, FT = federal threatened, SE = state endangered, ST = state threatened, SSC = state species of special concern, — = no listing status.

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Table 14-7. Vegetation species documented on Sagamore Hill.

Species	Scientific Name	Listing Status ¹	Source
Trees, Shrubs, and Vines			
Norway maple	<i>Acer platanoides</i>	—	LEC Environmental Consultants, Inc. 2008b
Red maple	<i>Acer rubrum</i>	—	LEC Environmental Consultants, Inc. 2008b
Speckled alder	<i>Alnus rugosa</i>	—	LEC Environmental Consultants, Inc. 2008b
Shadbush	<i>Amelanchier arborea</i>	—	LEC Environmental Consultants, Inc. 2008b
Japanese barberry	<i>Berberis thunbergii</i>	—	LEC Environmental Consultants, Inc. 2008b
Black birch	<i>Betula lenta</i>	—	TAJ Engineering, LLC 2017
Paper birch	<i>Betula papyrifera</i>	—	LEC Environmental Consultants, Inc. 2008b
Gray birch	<i>Betula populifolia</i>	—	LEC Environmental Consultants, Inc. 2008b
Ironwood	<i>Carpinus caroliniana</i>	—	LEC Environmental Consultants, Inc. 2008b
Oriental bittersweet	<i>Celastrus orbiculatus</i>	—	LEC Environmental Consultants, Inc. 2008b
American bittersweet	<i>Celastrus scandens</i>	ST	LEC Environmental Consultants, Inc. 2008b
Winged euonymus	<i>Euonymus alatus</i>	—	LEC Environmental Consultants, Inc. 2008b
American beech	<i>Fagus grandifolia</i>	—	LEC Environmental Consultants, Inc. 2008b
Huckleberry Huckleberry	<i>Gaylussacia baccata</i>	—	LEC Environmental Consultants, Inc. 2008b
Common winterberry holly	<i>Ilex verticillata</i>	—	LEC Environmental Consultants, Inc. 2008b
Creeping juniper	<i>Juniperus horizontalis</i>	—	LEC Environmental Consultants, Inc. 2008b
Eastern red cedar	<i>Juniperus virginiana</i>	—	LEC Environmental Consultants, Inc. 2008b
Sheep laurel	<i>Kalmia angustifolia</i>	—	LEC Environmental Consultants, Inc. 2008b
Tartarian honeysuckle	<i>Lonicera tatarica</i>	—	LEC Environmental Consultants, Inc. 2008b
Maleberry	<i>Lyonia ligustrina</i>	—	LEC Environmental Consultants, Inc. 2008b
Crab apple	<i>Malus sp.</i>	—	LEC Environmental Consultants, Inc. 2008b
Bayberry	<i>Myrica pensylvanica</i>	—	LEC Environmental Consultants, Inc. 2008b
Virginia creeper	<i>Parthenocissus quinquefolia</i>	—	LEC Environmental Consultants, Inc. 2008b

Table 14-7. Vegetation species documented on Sagamore Hill.

Species	Scientific Name	Listing Status ¹	Source
Eastern white pine	<i>Pinus strobus</i>	—	LEC Environmental Consultants, Inc. 2008b
Quaking aspen	<i>Populus tremuloides</i>	—	LEC Environmental Consultants, Inc. 2008b
Pin cherry	<i>Prunus pensylvanica</i>	—	LEC Environmental Consultants, Inc. 2008b
Black Cherry	<i>Prunus serotina</i>	—	LEC Environmental Consultants, Inc. 2008b
White oak	<i>Quercus alba</i>	—	LEC Environmental Consultants, Inc. 2008b
Northern red oak	<i>Quercus rubra</i>	—	LEC Environmental Consultants, Inc. 2008b
Glossy buckthorn	<i>Rhamnus alnus</i>	—	LEC Environmental Consultants, Inc. 2008b
European buckthorn	<i>Rhamnus frangula</i>	—	LEC Environmental Consultants, Inc. 2008b
Azalea	<i>Rhododendron periclymenoides</i>	—	TAJ Engineering, LLC 2017
Swamp azalea	<i>Rhododendron viscosum</i>	—	LEC Environmental Consultants, Inc. 2008b
Winged sumac	<i>Rhus copallinum</i>	—	LEC Environmental Consultants, Inc. 2008b
Staghorn sumac	<i>Rhus typhina</i>	—	LEC Environmental Consultants, Inc. 2008b
Pasture Rose	<i>Rosa carolina</i>	—	LEC Environmental Consultants, Inc. 2008b
Multiflora rose	<i>Rosa multiflora</i>	—	LEC Environmental Consultants, Inc. 2008b
Allegheny blackberry	<i>Rubus allegheniensis</i>	—	LEC Environmental Consultants, Inc. 2008b
Northern dewberry	<i>Rubus flagellaris</i>	—	LEC Environmental Consultants, Inc. 2008b
Raspberry Raspberry	<i>Rubus idaeus</i>	—	LEC Environmental Consultants, Inc. 2008b
Pussy willow	<i>Salix discolor</i>	—	LEC Environmental Consultants, Inc. 2008b
Sassafras	<i>Sassafras albidum</i>	—	LEC Environmental Consultants, Inc. 2008b
Common greenbrier	<i>Smilax rotundifolia</i>	—	LEC Environmental Consultants, Inc. 2008b
Meadowsweet	<i>Spiraea latifolia</i>	—	LEC Environmental Consultants, Inc. 2008b
American yew	<i>Taxus canadensis</i>	—	LEC Environmental Consultants, Inc. 2008b
American elm	<i>Ulmus americana</i>	—	LEC Environmental Consultants, Inc. 2008b
Lowbush blueberry	<i>Vaccinium angustifolium</i>	—	LEC Environmental Consultants, Inc. 2008b

Table 14-7. Vegetation species documented on Sagamore Hill.

Species	Scientific Name	Listing Status ¹	Source
Highbush blueberry	<i>Vaccinium corymbosum</i>	—	LEC Environmental Consultants, Inc. 2008b
Arrowwood	<i>Viburnum dentatum</i>	—	LEC Environmental Consultants, Inc. 2008b
Nannyberry	<i>Viburnum lentago</i>	—	LEC Environmental Consultants, Inc. 2008b
Grapevine	<i>Vitis spp.</i>	—	LEC Environmental Consultants, Inc. 2008b
Herbaceous			
Quackgrass	<i>Agropyron repens</i>	—	LEC Environmental Consultants, Inc. 2008b
Beardgrass	<i>Andropogon scoparius</i>	—	LEC Environmental Consultants, Inc. 2008b
Wood anemone	<i>Anemone quinquefolia</i>	—	LEC Environmental Consultants, Inc. 2008b
Wild sarsaparilla	<i>Aralia nudicaulis</i>	—	LEC Environmental Consultants, Inc. 2008b
Jack-in-the-pulpit	<i>Arisaema triphyllum</i>	—	LEC Environmental Consultants, Inc. 2008b
Common mugwort	<i>Artemisia vulgaris</i>	—	LEC Environmental Consultants, Inc. 2008b
Common milkweed	<i>Asclepias syriaca</i>	—	LEC Environmental Consultants, Inc. 2008b
Lilly-of-the-valley	<i>Convallaria majuscula</i>	—	LEC Environmental Consultants, Inc. 2008b
Queen Anne's lace	<i>Daucus carota</i>	—	LEC Environmental Consultants, Inc. 2008b
Hay-scented fern	<i>Dennstaedtia punctilobula</i>	—	LEC Environmental Consultants, Inc. 2008b
Spinulose woodfern	<i>Dryopteris spinulosa</i>	—	LEC Environmental Consultants, Inc. 2008b
Goosegrass	<i>Eleusine indica</i>	—	LEC Environmental Consultants, Inc. 2008b
Horsetail	<i>Equisetum sp.</i>	—	LEC Environmental Consultants, Inc. 2008b
Leafy spurge	<i>Euphorbia esula</i>	—	LEC Environmental Consultants, Inc. 2008b
Red fescue	<i>Festuca rubra</i>	—	LEC Environmental Consultants, Inc. 2008b
Fescue	<i>Festuca sp.</i>	—	LEC Environmental Consultants, Inc. 2008b
Wild strawberry	<i>Fragaria virginiana</i>	—	LEC Environmental Consultants, Inc. 2008b
Bedstraw	<i>Galium sp.</i>	—	LEC Environmental Consultants, Inc. 2008b
American wintergreen	<i>Gaultheria procumbens</i>	—	LEC Environmental Consultants, Inc. 2008b

Table 14-7. Vegetation species documented on Sagamore Hill.

Species	Scientific Name	Listing Status ¹	Source
Wild geranium	<i>Geranium maculatum</i>	—	LEC Environmental Consultants, Inc. 2008b
Bluets	<i>Hedyotis caerulea</i>	—	LEC Environmental Consultants, Inc. 2008b
Hawkweed	<i>Hieracium gronovii</i>	—	LEC Environmental Consultants, Inc. 2008b
Jewelweed	<i>Impatiens capensis</i>	—	LEC Environmental Consultants, Inc. 2008b
Indian tobacco	<i>Lobelia inflata</i>	—	LEC Environmental Consultants, Inc. 2008b
Tree clubmoss	<i>Lycopodium obscurum</i>	—	LEC Environmental Consultants, Inc. 2008b
Canada mayflower	<i>Maianthemum canadense</i>	—	LEC Environmental Consultants, Inc. 2008b
Mint	<i>Mentha sp.</i>	—	LEC Environmental Consultants, Inc. 2008b
Partridge berry	<i>Mitchella repens</i>	—	LEC Environmental Consultants, Inc. 2008b
Indian Pipe	<i>Monotropa uniflora</i>	—	LEC Environmental Consultants, Inc. 2008b
Common evening primrose	<i>Oenothera biennis</i>	—	LEC Environmental Consultants, Inc. 2008b
Missouri evening primrose	<i>Oenothera macrocarpa</i>	—	LEC Environmental Consultants, Inc. 2008b
Sensitive fern	<i>Onoclea sensibilis</i>	—	LEC Environmental Consultants, Inc. 2008b
Cinnamon Fern	<i>Osmunda cinnamomea</i>	—	LEC Environmental Consultants, Inc. 2008b
Royal fern	<i>Osmunda regalis</i>	—	LEC Environmental Consultants, Inc. 2008b
Timothy	<i>Phleum pratense</i>	—	LEC Environmental Consultants, Inc. 2008b
Common plantain	<i>Plantago major</i>	—	LEC Environmental Consultants, Inc. 2008b
Harry Solomon's seal	<i>Polygonatum pubescens</i>	—	LEC Environmental Consultants, Inc. 2008b
Japanese knotweed	<i>Polygonum cuspidatum</i>	—	LEC Environmental Consultants, Inc. 2008b
Knotweeds	<i>Polygonum sp.</i>	—	LEC Environmental Consultants, Inc. 2008b
Hair-cap Moss	<i>Polytricum sp.</i>	—	LEC Environmental Consultants, Inc. 2008b
Creeping buttercup	<i>Ranunculus repens</i>	—	LEC Environmental Consultants, Inc. 2008b
False Solomon seal	<i>Smilacina racemosa</i>	—	LEC Environmental Consultants, Inc. 2008b
Steeple bush	<i>Spiraea tomentosa</i>	—	LEC Environmental Consultants, Inc. 2008b

Table 14-7. Vegetation species documented on Sagamore Hill.

Species	Scientific Name	Listing Status ¹	Source
Skunk cabbage	<i>Symplocarpus foetidus</i>	—	TAJ Engineering, LLC 2017
Dandelion	<i>Taraxacum officinale</i>	—	LEC Environmental Consultants, Inc. 2008b
Poison ivy	<i>Toxicodendron radicans</i>	—	LEC Environmental Consultants, Inc. 2008b
Star flower	<i>Trientalis borealis</i>	—	LEC Environmental Consultants, Inc. 2008b
Red clover	<i>Trifolium pratense</i>	—	LEC Environmental Consultants, Inc. 2008b
White clover	<i>Trifolium repens</i>	—	LEC Environmental Consultants, Inc. 2008b
Clover	<i>Trifolium sp.</i>	—	LEC Environmental Consultants, Inc. 2008b
Common mullein	<i>Verbascum blattaria</i>	—	LEC Environmental Consultants, Inc. 2008b
Cow vetch	<i>Vicia cracca</i>	—	LEC Environmental Consultants, Inc. 2008b
Common vetch	<i>Vicia sativa</i>	—	LEC Environmental Consultants, Inc. 2008b
Common blue violet	<i>Viola papilionaceae</i>	—	LEC Environmental Consultants, Inc. 2008b

4746 ¹ FC = federal candidate for listing, FE = federal endangered, FT = federal threatened, SE = state endangered, ST =
 4747 state threatened, SSC = state species of special concern, — = no listing status.
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Table 14-8. Federally- and state-listed plant species documented at Hanscom Air Force Base, Fourth Cliff Recreational Annex, and/or Saga more Hill Solar Weather Observatory.

Family	Scientific Name	Common Name	Listing Status ¹
Violaceae	<i>Viola brittoniana</i>	Britton's violet (Mass.gov) or northern coastal violet (USDA Plants)	ST
Cyperaceae	<i>Cyperus engelmannii</i> (Mass.gov) or <i>Cyperus odoratus</i> L. var. <i>engelmannii</i> (USDA Plants)	Engelmann's flatsedge (Mass.gov) or fragrant flatsedge (USDA Plants)	ST
	<i>Carex oligosperma</i>	Few-seeded sedge (Mass.gov) or few-seeded sedge (USDA Plants)	SE
	<i>Scirpus longii</i>	Long's bulrush	ST
Portulacaceae	<i>Claytonia virginica</i>	Narrow-leaved spring-beauty (Mass.gov) or Virginia springbeauty (USDA Plants)	SE
Asteraceae	<i>Liatris novae-angliae</i> (Mass.gov) or <i>Liatris scariosa</i> (L.) Willd. var. <i>novae-angliae</i> Lunell	New England blazing star	SSC
Poaceae	<i>Aristida tuberculosa</i>	Seabeach needlegrass (Mass.gov) or seaside threeawn (USDA Plants)	ST
Orchidaceae	<i>Isotria medeoloides</i>	Small whorled pogonia	FT, SE

¹ FT=federally threatened, SE=state endangered, SE=state threatened, SSC=state species of special concern.

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4751 **15.0 ASSOCIATED PLANS**

4752 ***Tab 1—Integrated Cultural Resources Management Plan***

4753 ***Tab 2— Integrated Pest Management Plan***

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