PROJECT DESCRIPTION

Plan for Transformative IPY Research and Education: This proposal seeks to make use of the IPY research surge to build and reinforce international interdisciplinary collaborations that can allow ambitious science & education programs beyond the capacity of any single research team or national research effort and leave a lasting IPY legacy. This proposal forms one component of a larger international effort to do something never before accomplished in N Atlantic archaeology- the direct and continuous connection of field projects in different islands, each aiming at a regional (rather than single site focused) perspective, each working to integrate multi-disciplinary research, education, and community outreach. Doing a good job of multi-site, regional-scale archaeology in any northern setting is challenging, closely coordinating three regions at once is daunting, and trying to explain each program in sufficient detail for reviewers in the necessarily tight confines of an NSF proposal is to seek yet another level of difficulty. We have accepted these challenges because we believe that the archaeology & human ecology of the Norse North Atlantic can no longer be productively investigated as a separate set of islands, each with its own isolated research tradition, each producing basic data sets which may or may not match up in the critical areas of detail. The Norse expansion across the N Atlantic in the Viking Age was an event that connected all these research areas, and in the period we study this whole quarter of the circumpolar north was united by language, culture, and economy. We cannot effectively compare our diverse island cases if they are studied in isolation, and the important lessons we feel the Norse N Atlantic offers to modern problems of community sustainability and global change will be lost without the broader perspective. We believe that graduate and undergraduate students now entering northern research will experience international cross disciplinary system science as their working environment for the rest of this century, and they need training, contacts, and practical experience now to fit them for global science in the future. We believe that the different local island communities among whom we work face similar problems of educational outreach and effective tourist management, and that they are owed the chance to interact with each other and (like the scientists) pool best practice and share resources. We also believe that a decade of sustained international cooperation under the NABO research cooperative (supported by US and European funds) has prepared the participating research teams to work closely together in the field and laboratory. We believe we are ready to take the cooperative effort to the next level and achieve a genuinely *transformative breakthrough* in international research and education in this part of the circumpolar north.

Results of Prior NSF Support *NB: to avoid duplication full citations of all publications resulting are in the References section, those marked with * derive from prior NSF support. Note that following NSF proposal preparationl guidelines we do not provide website references to projects or organizations.*

Grant (BCS 0001026) ***Landscapes of Settlement: Historical Ecology of the Colonization of Northern Iceland*** , 2000-02, Co PI's Thomas McGovern (Anthropology, CUNY), Orri Vésteinsson (Arch Inst. Iceland), &y Dugmore (Geography U Edinburgh), Ian Simpson (Envir. Sci. U Stirling), $194,000. Res. Experience for Undergrad (REU) supplement 2002 $8,000. The *Landscapes of Settlement of Northern Iceland (LOS)* project was an international multi-disciplinary investigation of the complex interactions of human political economy, climate, & landscape in the context of first human settlement of Iceland. It has focused upon the high altitude inland Lake Mývatn region. NSF support for the LOS project has transformed our understand of human-environmental interaction in Iceland & provided practical experience in managing & coordinating long term multi-investigator cross-disciplinary research in a northern setting. The LOS investigations have been regularly reported in both Icelandic & English in annual reports (FSI 1995, 1996, 1997, Friðriksson & Vésteinsson 1993, 1995, 1996, 1997b, 1998a-d, Lucas 1998, 1999, 2000, 2001, Vésteinsson 2001, 2002,) & papers in reviewed journals (Adderley et al. 2000, 01, in press, Amundsen et al 2006, Einarsson et al 2001, Friðriksson & Vesteinsson 1997, Friðriksson, et al 2002, McGovern & Ogilvie 2000, McGovern, Perdikaris, & Tinsley 2001, McGovern & Perdikaris 2003, McGovern et al. 2006a,b, Milek et al. 2002a, 2002b, Milek, Perdikaris et al. 2003 Perdikaris 2003, Simpson et al 2002, Simpson, Milek & Guðmundsson 1999, Simpson Dugmore et al. 2001, Tinsley 2004a,b, Vésteinsson et al 2002, Vésteinsson 2000b, 2001a, 2002, , Vésteinsson McGovern & Keller 2002, Fridriksson et al 2004, Tinsley Amundsen et al 2005, Perdikaris & McGovern 2005a, b, 2006,), one doctoral thesis has resulted (Thompson 2003). A major high-profile summary appears in the March 2007 issue of *American Anthropologist* (McGovern et al 2007) and a major Hofstaðir monograph will appear in 2007. This successful and mature regional-scale interdisciplinary project will provide one anchor for the proposed IPY fieldwork.

Grant OPP 402900001: ***Northern Science & Education Program REU*** ($395,000). Renewed 2004-06 Funding for 7 undergraduates & 2 graduate student peer mentors per year. Senior-PI: Dr. S. Perdikaris, Co-

PI: T.H. McGovern. An innovative combined sites & field REU award to Perdikaris from NSF OPP Arctic Social Sciences 2000-06 has allowed a full year program for a limited number of high-achieving ethnically diverse inner city undergrads to participate in the NABO field school in Iceland & also in a two semester program of selected graduate level courses (including a real-time distance learning Geoarchaeology course taught by Ian Simpson simultaneously at Stirling & Brooklyn), intensive hands-on laboratory training with participating PhD's & grant- funded grad student peer mentors. A cooperative agreement with the *American Museum of Natural History* has provided REU students with special internships allowing hands on participation in the Museum's research & education work. Student participants have won major awards & fellowships (including NSF Doctoral Fellowships & an Intel Science scholarship), & 19 participants (of 21 in years 1-3) are now in graduate programs (three in northern anthropology), & have made the most of publication & poster presentation opportunities (Amundsen 2005, Edvardsson et al 2004, Krivogorskaya et al 2005, Harrison et al 2006). This program was allowed a renewal for 2004-06 by NSF OPP Arctic Social Sciences & has been identified as one of the most successful long term educational outreach programs in the N Atlantic region by the *U Arctic* international program. The experience gained in this program will be directly applied to the education & outreach portions of the current proposal.

Grant OPP ARC - 0352596 ($199,812) ***Comparative Zooarchaeology & Human Ecodynamics in Iceland & the Faroe Islands*** (2004-06 all funds expended) PI & Senior Staff: T.H. McGovern, Sophia Perdikaris, Andy Dugmore, Orri Vésteinsson, Ian Simpson, Claus Andreasen, Jette Arneborg, Ragnar Edvardsson. The grant provided support for a coordinated program of zooarchaeology & environmental archaeology that initially connected research projects in Iceland (Mývatn & NW) with new excavation work on Sandoy in the Faroe Islands. This produced the first integration of zooarchaeology, archaeobotany, palynology, & soil science from the Faroes (Arge et al 2005, Church et al 2005 Lawson et al 2005) & has formed the basis for a highly productive inter-island exchange of ideas & people which has led to a multi-season linkage of Iceland, Faroes, & the Shetland Islands in a rapidly expanding program of scientific collaboration, student exchange, & cooperation in community based tourism development (*Heart of the Atlantic* Project). In 2005 (with NSF permission) the project was successfully extended to Qassiarsuk in SW Greenland with a small cooperative midden excavation at the site of Brattahlið N Farm (first excavated in 1932). The summers of 2005-06 saw very international teams of excavators from US, UK, Finland, Poland, Denmark, Faroes & Iceland led by Ragnar Edvardsson (an Icelandic advanced doctoral student at CUNY) work in Greenland, Iceland, and the Faroes in the same (heavily scheduled) summers. This cooperative zooarchaeology project had evolved by 2006 into a multi-disciplinary collaboration spanning four island communities, indicating the degree of interest among scholars & local communities such cooperative efforts, and this experience provides key elements of the present proposal. The output of the grant thus far includes PhD theses (Casely 2005, Edvardsson dep. 2007) an MA thesis (Harrison 2005), an entire dedicated issue of *Human Ecology* (Edwards 2005, Arge et al 2005, Edwards, Borthwick et al. 2005, Lawson et al 2005, Vickers et al. 2005, Adderley & Simpson 2005, Thomson et al 2005, Church et al. 2005b), & other peer reviewed articles providing preliminary comparative syntheses of marine & terrestrial resource use in Iceland, Faroes, & Greenland (Amundsen et al 2005, Arge 1988 et seq., Arge et al 2005, Edvardsson & McGovern 2005, Edvardsson 2005, Harrison, Brewington et al. in press, Krivogorskaya et al 2005, in press a, b, McGovern, Perdikaris et al 2006, Perdikaris & McGovern 2006a, 2006b, 2007). The current proposal seeks to draw on the accumulated experience of prior NSF support to the regional research community & to maintain the momentum already created for more intensive international cooperation generated by the IPY initiative in Greenland, Iceland, and the Faroes.

Research Design

Relevance to IPY goals: The current proposal requests support for the US component of the IPY-recognized MARENA-NORCLIM programs. This proposal is part of an umbrella program *MARENA* (Maritime Adaptations & Resource Exploitation in the N Atlantic) chaired by Orri Vésteinsson (U Iceland) which connects the current proposed research in Iceland, Faroes, & SW Greenland to a series of related projects (***not included*** in this proposal budget) in the Shetlands, N Scotland, arctic Norway, & Canada. MARENA has been officially approved by ICSU/WMO/IPY as a European IPY project (#387) as part of the larger cross disciplinary *focus project* NORCLIM "*Northern High Latitude Climate Variability During the Past 2000 Years: Implications for Human Settlement*" (#129). While the current proposal represents a self-sufficient program of research & education, it is integrated with closely coordinated international IPY projects sharing personnel, logistics, & data comparability & management standards through MARENA/NORCLIM and the NABO research cooperative (see "data management plan" and "international collaboration" in the required IPY Supplementary Documents). Our contribution will be the

coordination of midden excavations, zooarchaeological analysis, and student training. While other components of the overall project (site survey, structure excavations. historical climatology, archaeobotany, geoarchaeology, land use models, climate impact models, and community outreach coordination) will be mentioned, these are the responsibility of other MARENA-NORCLIM teams, not funded through this proposal, and thus the project description will focus primarily upon the proposed US contributions in zooarchaeology for which this proposal does request support. This proposal will 1) attempt to put the project into broader perspective and demonstrate relevance, 2) discuss project management structure, data management strategy, education program, common project goals, and 3) provide more detailed descriptions of proposed fieldwork activities. ***Relevance to NSF Program Goals:*** In the past five years NSF has catalyzed interdisciplinary research, with emphasis on the *complex environmental system* (CES) framework to provide pathways for enhancing *environmental research & education* (ERE), and funding several major cross-cutting initiatives such as *Biocomplexity in the Environment* (BE) which stressed bridging the natural science-social science boundaries. Disciplinary developments within archaeology and environmental science have both responded to and led such NSF programmatic initiatives. The first decade of the 21st century has seen archaeology & paleoecology take up the "archaeology of global change" aimed at illuminating modern problems as well as better documenting past human – environmental interactions (Hardesty 2007, Redman et al 2004). Much of this new interdisciplinary archaeological activism is founded on the theoretical agenda of the *Historical Ecology* movement first articulated by Crumley et al (1994) & expanded by Baleé (1998) & Hunt & Kirch (1997). Redman's influential overview (1999) presaged a strong archaeological response to the early NSF CES initiatives. This proposal explicitly builds upon the integrative tradition of Historical Ecology (McGovern 1994) to directly take up the NSF CES/ERE challenge of interdisciplinary science and education. ***Relevance to Disciplinary Goals***: *American Anthropologist* is currently highlighting examples of this new research orientation in a special "In Focus" series, including NABO research in N Iceland (*Landscapes Over Time: Resilience, Degradation, & Contemporary Lessons* : Redman 2005, Fisher & Feinman 2005, Krech 2005, Fisher 2005, Johnson et al 2005; *The Archaeology of Global Change: the Long Term Perspective on Sustainability & Collapse*: Kirch 2007, Woollett 2007, McGovern et al 2007, Hardesty 2007, Wilkinson et al. 2007). A recurring pattern in the studies of the "archaeology of global change" is the effective use of a well developed body of regional archaeological & environmental data that can be expanded by carefully targeted joint field work & integrated through one or another form of climate-landscape modeling to produce new perspectives on problems of wide interest (desertification, deforestation, erosion, salinization, rapid climate change, fisheries depletion). The current proposal thus forms part of a growing movement in archaeological, geographical, & anthropological research which is rapidly placing these disciplines at the cutting edge of the investigation of long term human ecodynamics & the human dimensions of complex environmental systems (Redman et al. 2004, Gunderson & Folke 2003). ***Regional Research Integration:*** The past decade has seen major advances in connecting environmental & economic archaeology with natural science on a regional scale in the North Atlantic, aided in part by NABO general meetings (Bowdoin 1988, NYC 1992, Glasgow 1994, St.John's 1997, Glasgow 2001, Copenhagen 2003, Quebec 2006) with conference proceedings (Bigelow 1991, Morris & Rackham 1994, Housley & Coles 2004, Grønnow et al 2006), and many smaller workshops. Research proposed here will thus be assured of wide dissemination (*Human Ecol., Envir. Arch., Arctic Anthrop., Am. Anthro*) & full integration into a larger regional research effort, and will directly address major regional research problems. **Public Outreach & Northern Community Development:** The NABO North Atlantic teams have been active in outreach & education on both the international & local scale & the current proposal places a high priority upon the effective communication of results to the public who ultimately fund research (Carman & Keitumetse 2005, Olafsdóttir et al. 2000, Pinter 2005, Pringle 1997, Zorich 2007). Prior work has featured in PBS & Discovery Channel TV specials as well as in many local Icelandic, Greenlandic, & Faroes media, & the present PI's were closely involved with highly successful traveling Smithsonian *Viking Voyagers* exhibition & the resulting volume, which won the Soc. Am. Arch. Book of the Year award for 2001(Arneborg 2000, Arge 2000, McGovern 2000, Ogilvie & McGovern 2000, Vésteinsson 2000). The NY Times best seller *Collapse* by Jared Diamond (2004) draws roughly a third of its material from the Norse N Atlantic, & we worked closely with the author in providing information (some now already dated by the pace of research). The NABO human dimensions research program has recently been featured in keynote speeches by Dugmore to the *Human Security & Climate Change* conference in Oslo & Pell Center for International Relations & Public Policy (both 2005) thus working to "ensure that their research is used to support more effective decision making" (NSF CRE 2005). The CUNY team is representing northern social science at a special IPY Weekend

(March 07) organized by the American Museum of Natural History (AMNH). We will work closely with other NSF IPY public outreach teams to produce high quality digital imagery, interactive software & other materials suitable for national & international outreach. In addition, we are committed to involving local communities in research projects as active partners, and regularly work with community organizations & local institutions to help them deal effectively with the potentials & problems of rapidly expanding cultural/environmental tourism (in N Iceland income from tourism has increased 300% in 10 yrs). Iceland has become a leader in digital graphics & interactive programming, & the newly renovated National Museum in Reykjavik and the "Reykjavik AD871+/-2" interactive exhibit (Sverrisdottir 2006) are world class examples of effective integration of artifacts & interactive digital technology, which can be adapted to smaller museum & heritage center settings in many parts of the circumpolar north. While local communities will manage their own economic development, we can help by providing connections to allow effective sharing of local resources (such as Icelandic computer skills) & international scientific resources among small (but no longer isolated) northern communities. We thus request support for a small "stake holder's meeting" in Iceland in 2008 to aid community-to-community connections as well as science-to-community connections. As responsible NSF-funded scholars, we fully support and subscribe to the OPP "Principles of Scientific Research in the Arctic".

Education: The current proposal requests support for student mobility funds which will allow US & international graduate students to participate fully in the interdisciplinary, international research projects in the three islands. This builds upon experiences in 2005-06, when small sums of mobility money from CUNY were used to allow Faroese archaeology students to move from work on Sandoy in the Faroes to projects in Iceland & Greenland the same summer, & to allow US students to work with them in Sandoy & Iceland. We intend to aid students at the BA/MA/ABD level from US, Canada, Greenland, Scandinavia, and the EU to work together on field projects in Faroes, Iceland, and Greenland to provide them with international connections, peer mentoring, and a chance to share field schools among multiple scholarly traditions. We have found it extremely productive to foster such genuinely international teams consisting of senior scholars (with multiple decades of field experience but growing issues with knees & backs) with junior PhD's (usually controlling cutting edge technical skills), advanced & beginning graduate students & promising undergraduates (who provide peer mentoring, role models, & youthful vigor respectively). While *not requested for funding in this proposal*, NABO field schools in Iceland (Vatnsfjord for graduates, Holar for undergraduates: a CUNY, U Iceland, U Holar, U Oslo collaboration) & in Shetland (with Bradford U) have shared students & staff since 1997, & have trained graduate & undergraduate students of 27 nationalities & ethnicities in N Atlantic interdisciplinary field research (including China, Uzbekistan, Eastern Europe, & North American First Nations), & will continue to provide an academically structured venue for students & staff interactions during the proposed project. We have also made use of fieldwork to encourage local students to get involved in archaeology & environmental science, & it is pleasant to report that Margreta Jensen, the daughter of the farmer who owns the land under excavation at Sandur in the Faroes, has been accepted as to the archaeology program at Aarhus University after working as a volunteer on site. Beginning in 2008, a ***NABO/FSI/Icelandic School System*** collaboration will make use of excavations in the Mývatn area to develop a hands-on participatory learning experience aimed at rural Icelandic high school students, with a print and digital teachers' module intended to integrate environmental science and archaeology instruction. The Icelandic students will make use of distance learning technology to interact with NYC students participating in an AMNH Education Department initiative, and with Caribbean students participating in an Antigua Museum program based on cooperative CUNY /Antigua Museum work on the island of Barbuda. While NOT included in the current proposal budget, this "international kids IPY archaeology" program will work to develop connections and shared awareness of northern peoples, history, and environment in secondary schools to meet IPY goals as well as developing shared teaching materials and international connections.

Common Standards: IPY goals require basic comparability in data collection, analysis, curation, & reporting. Since 1992, the NABO cooperative has used workshops & working group meetings (funded by NSF, Wenner-Gren Foundation, Danish, Canadian, Icelandic, & UK sources) to hammer out a set of mutually acceptable "best practice" manuals & recording systems & to produce a series of data management products aimed at solving community-identified impediments to research (FISHBONE digital fish bone ID manuals, NABONE recording system). The sustained community cooperation that has produced these basic standards & tools for comparability now places North Atlantic zooarchaeology in a solid position to contribute to the CES & IPY vision of cross-disciplinary, multi-scalar, integrative science. In field excavation, the development & dissemination of a common field manual (3rd ed, Lucas 2003),

based on successive seasons of field excavation on multiple sites in Iceland by the Arch. Inst. Iceland (FSI) excavation teams & NABO environmental specialists has had a major regional impact, with versions already applied to field projects in the Faroes and Greenland. The manual provides illustrated examples of solutions to common N Atlantic excavation & recording problems, sets recovery standards, and provides pre-tested recording forms keyed to digital archives & best-practice suggestions for environmental sampling & recovery. The FSI manual & associated archaeological data management system are the main Icelandic contribution to the EU ARENA (Archaeological Records of Europe: Networked Access) program & represent a world-class system as well as a regional standard (Aldred 2005). The NABONE recording and data archive system is now in its 8th edition, and has been used for basic zooarchaeological recording from N Norway, Iceland, Faroes, Greenland, and several N American projects (see below). The NABO network has thus developed some well tested & widely reviewed standards, research tools, & data management structures which have already transformed the process of archaeological excavation, analysis & reporting in our region.

Data Management and Comparability: Expanding the use of common standards, digital tools, & data management structures is a major objective of the present proposal. Following IPY and existing OPP "guidelines and award conditions for scientific data", long term data and metadata archiving will be carried out at international and national centers (ARCSS Data Coordination Center U Colorado, National Museum of Denmark, Faroes Museum, MARENA data center at the Archaeological Institute Iceland), with primary responsibility for zooarchaeological data and metadata resting with McGovern at CUNY (see Data Interchange Format (DIF) and confirming letters in Supplementary Documents). **All** our zooarchaeological data sets are "common data" by IPY & NSF definition and are distributed to all project members and all other interested scholars as soon as data checking and validation is completed and prelim report produced (public distribution is via download from NABO website maintained by U Edinburgh and CUNY as well as via the NABONE CD package). We believe that wide distribution at multiple national data centers and free and open access to basic data sets are key elements to a successful long term data management and curation program, and should ensure the long term availability of IPY data for future workers. Rapid turn around time on analysis and reporting of archaeofauna is a major objective of the present proposal and thus support for trained zooarchaeology grad students is a key budget item.

Operational Feasibility: Shared Research Experience & Maximized Logistics The NABO research cooperative has developed stocks of field equipment (ranging from shovels & tents to joint use 4 WHD vehicles, mapping GPS units & resistivity survey apparatus, see *facilities available* for details), which have the effect of reducing the costs of individual northern field projects & rationalizing the use of expensive items. Stocks of bulky gear (hand tools, plastic bags, sieves, tents, site shelters, etc.) have been pre-positioned at the Faroes Museum, Archaeological Inst. Iceland, & S. Greenland. Most large-ticket items are in fact joint purchases involving several nations & institutions. The jointly-purchased Land Rovers function as self-propelled shipping crates, moving between Aberdeen, Shetland, Faroes, & Iceland on the inter-island ferry. Perhaps most important, the long collaborative effort has produced inter-locking teams of fieldworkers from different nations who are now used to working with each other & making use of common techniques. The research teams have learned to operate on carefully integrated field schedules which allow effective coordination of long field seasons spanning multiple islands. Prior work in Greenland in 2005-06 has already allowed for productive and effective use of the *VECO Polar Services* contractor in supporting fieldwork with high quality camping gear, satellite phones, and shipping (see VECO Newsletter Aug 2006). *An IPY-friendly, coordinated international approach maximizing both impact & cost effectiveness* will allow maximum use of research funding & eliminating duplication of logistics. Note that the present proposal DOES NOT request field equipment purchase despite intensive field work, significantly reducing the overall budget.

Project Management Plan: While each participating project has a responsible fieldwork PI (Arneborg: Greenland, Arge: Faroes, Vésteinsson: Iceland), management is in fact highly collegial. Overall MARENA management is by Vésteinsson (U Iceland). Landuse modeling & geoarchaeology will be coordinated by U Stirling (Simpson), climate modeling & tephrochronology by U Edinburgh (Dugmore), archaeobotany by U Durham (Church), paleoclimatology by NORCLIM center in Amsterdam (Troelstra) and field archaeology by the SILA Center of the Danish National Museum (Arneborg), Greenland Museum and Archives (Andreasen), Archaeological Institute Iceland (Vésteinsson), Faroes Museum (Arge), Bradford Univ. (Dockrill & Bond), with AMS Radiocarbon and isotopic assay provided by the Scottish Universities Reactor Center (Gordon Cook). Zooarchaeological analyses will be coordinated by McGovern & Perdikaris (CUNY) with specialist work carried out by Mainland (Bradford), Ascough (St. Andrews), and Woollett

(Laval). The NABO cooperative sponsors semi-annual large meetings (next Bradford 08) and smaller workshops, and these are used to coordinate fieldwork as well as report on results. For this project, we also anticipate three video-conference meetings per year for each project, with an additional two (fall and spring) involving all MARENA members. At least one face to face meeting of project leaders and key specialists will take place each year, but we intend to schedule these around existing meetings and fieldwork travel rather than separately charging this project budget. We will publish in *The Holocene, Journal of Archaeological Science, Archaeologica Islandica, Environmental Archaeology, American Anthropologist, Arctic Anthropology, and Human Ecology* as well as making use of the new *Journal of the North Atlantic* and two planned edited volumes in the Springer Historical Ecology series.

Common Field Methods: While each archaeological site has its own problems and potentials, and excavation remains a skilled craft rather than a laboratory exercise, common standards of recovery and documentation will be carried out on all three field project areas. Middens will be a key objective throughout, and will be excavated stratigraphically (usually making use of both vertical and horizontal approaches simultaneously) and zooarchaeologist/excavators will ensure that articulations are observed and field documented, and that tooth-rows and other vulnerable elements are recovered effectively. Resistivity GPR and magnetometer survey are sometimes useful in locating middens (Horsley 2005), but a simple Oakfield type tube corer usually provides a rapid means of localizing deep midden deposits and aiding in locating excavation units. Since we need very substantial NISP counts per phase for the planned zooarchaeological analysis, midden excavation strategy wherever feasible will involve the stripping off of a wide open area (up to 10 x 10 m) and taking the surface down in phase (making use of temporary mini-baulks and older excavation units and erosion for vertical control) rather than narrower "telephone booth" units. While small test pits have their uses, any excavation which gets the stratigraphy wrong because of too short profiles or insufficient horizontal exposure is ultimately not worth anything- the time and labor committed to a bigger unit with a better synchronic and diachronic view has proven a far better investment for zooarchaeology. The open-area strategy has proved very productive in Iceland, and has been effective in revealing and effectively documenting earlier phase structures and yard walls covered by later midden deposits as well as picking up activity areas on the midden surface. Much of the requested field budget is aimed at putting enough trained workers into the field to successfully carry out this labor intensive but ultimately cost-effective approach. Soil pH and other conditions affecting attrition and taphonomy will be systematically recorded. All midden deposits will be 100% sieved through 4mm mesh dry sieve but with an approximate 7-10% whole soil sample retained for flotation and 50 micron mesh (flotation will be carried out by the Durham team who will have responsibility for separating small macrofloral remains from bone fragments). For the first time, common field methods carried out by over-lapping teams of excavators and supervisors will provide the level of inter-site & inter-regional recovery comparability that will allow synthesizers to fully control for excavation biases in analyzing observed variability in the recovered data.

Common Laboratory Methods: Following a 1997 meeting of 27 active N Atlantic zooarchaeologists, the working group developed the NABONE zooarchaeological recording & analysis system which was then tested for consistency by different laboratories (and by successive classes of zooarch students) to reach its 8th edition (NABONE 8.0) by 2007. NABONE 8.0 (based on MS Access and Excel) now allows direct comparability for reliable multi-site comparison on a bone-by-bone level for multiple archaeofauna from Finnmark to Faroes, Iceland, Greenland & Labrador from 9th to 19th century, with common standards for recording & reporting taphonomic evidence (fragmentation, butchery, burning, & tooth marking) as well as element & species abundance (NISP, MNI, DD, MAU data automatically calculated), & the package comes with quantitative & qualitative tools for pattern recognition & charting to aid analysis. NABONE 8.0 (with sample data sets) is now distributed *gratis* as part of a CD package which includes FISHBONE 3.1 . (Krivogorskaya et al. 2003) an interactive digital aid using both photos & drawings for the identification of most of the skeletal elements of the different cod-family (Gadidae) fish commonly encountered in N Atlantic zooarchaeology. Use of these common tools for identification, quantification, and data presentation greatly enhances the comparability of data sets and the portability and archiving of basic bone-by-bone information critical to future re-analyses as well as current publication. Calculation of measures like MNI or element distribution becomes transparent, and while a standardized directly comparable output can be generated by the NABONE package, the raw data remain available for manipulation by other packages and other researchers with different questions. Metadata on the collection, recovery and, site taphonomic characteristics will be comparatively easily integrated into the existing NABONE data structure (see Data Management in required IPY supplementary materials).

Specialist Analysis (Zooarchaeology): While the CUNY labs will carry out basic taxonomic identification and the labor intensive initial sorting involved in zooarchaeology, we will also collaborate closely with expert colleagues in the UK and Canada for specialist analyses. While small sums are requested in the current budget to aid these analyses, reviewers will recognize that these are essentially covering expendables and minimal bench space costs**. Tooth wear and surface micromorphology** will be studied by Dr. Ingrid Mainland (Bradford) using SEM imagery and image analysis techniques designed to track grazing patterns and dental erosion rates on domestic mammals (Mainland 1998 et seq.) Mainland is a recognized expert in this area and has already carried out important studies of the micromorphology of caprine tooth wear in different parts of the N Atlantic demonstrating that her technique effectively picks up different amounts of ingested soil grit (and thus pasture erosion). She has collected excellent modern control data from farm experimental stations in Greenland and Iceland, as well as pioneering new approaches to reconstructing herding patterns from tooth eruption and wear in Greenland (Mainland and Halstead 2005, Mainland 2006). Her work will be key to tracking different feeding patterns in Faroese, Icelandic, and Greenlandic livestock, and in detecting changes through time related to herding pattern and erosion. **Incremental Analysis of seal teeth** from excavations in Greenland will be carried out by Dr. Jim Woollett (U Laval, Quebec), who will do the specimen preparation and analysis of the dentine/enamel ring structures. Incremental (often annual) structures in enamel and dentine of seal teeth have long provided seasonality data for Inuit archaeofauna, but the technique has thus far been only sporadically applied to Norse Greenland (McGovern et al 1996). Woollett is a recognized expert in seal zooarchaeology, and has applied incremental analysis extensively in his own research in Labrador (2003, 2006, Woollett et al. 2000). The more effective reconstruction of the Norse seal hunt in Greenland is a key project goal (see below), and seasonality indicators will be a critical element in this investigation. **Carbon and Nitrogen isotope signatures:** the use of stable C and N isotopic signatures from bone has moved beyond assessing radiocarbon assays for potential marine components, and towards the reconstruction of food chains and the dietary patterns of both herbivores and carnivores. Arneborg et al (1999, 2007), Cook et al (2001), Ascough et al. (2004), & Ascough (2007) have been leaders in the application of stable C & N isotopes to such reconstruction work in the N Atlantic area. Linking traditional osteological approaches with such innovative isotopic analyses has already sparked multiple new research questions in the N Atlantic and elsewhere, and will directly contribute to several joint project research themes.

Joint Research Themes: The cooperating NABO/MARENA IPY projects share a set of common overall research themes which include: 1) **Human impact on island ecosystems**: 2**) Interacting subsistence and exchange economies, 3) Climate impacts,** each of which has a major zooarchaeological component.

1) Human impacts: the export of European animals and economies to the offshore islands of the N Atlantic was once thought to be a uniform story of "rape, ruin, and starve", or at least of massively adverse unintended consequences resulting from false analogy to Scandinavian or British isles ecosystems that led to overstocking, overgrazing, and rapid soil erosion- producing treeless, eroded "ovigenic" landscapes vulnerable to climate change (e.g. McGovern et al 1988; Diamond 2005). The impact of Norse hunters on island wildlife (birds, seal, and walrus) was seen a decade ago as essentially exploitive drawing down of natural capital accumulated since early Holocene times to finance the establishment of new farming communities (Amorosi et al. 1997). These views now appear simplistic, and certainly fail to encompass the actual range of Norse interactions with island landscape, flora, and fauna, which includes clear examples of millennial-scale sustainable use as well as over exploitation (Dugmore et al 2005; McGovern, Perdikaris et al. 2006). We do not yet understand why and how seabirds were sustainably managed in the Faroes, but apparently drawn down in S Iceland. We do not understand why fishing was a core element in the early Viking age settlements in Iceland and Faroes, but not in Greenland. We do not fully understand the caprine (sheep and goat) herding strategies (which have been implicated in deforestation and erosion) in either Greenland or Faroes, and our understanding in Iceland is currently sharply constrained in time and space. We do not understand the changing role of pigs in the economies of the three islands or their role in deforestation or erosion, though isotopic evidence suggests some very different feeding practices on different islands, and even on different farms within a single study area (McGovern et al 2007). At present, it is fair to say that we have enough new zooarchaeological and isotopic data to strongly indicate that our impact models of the 1990's are simply wrong, and that we now have tools and the IPY opportunity to get a more accurate comparative picture of both sustainable and ultimately unsustainable herding practices.

2**) Interacting subsistence and exchange economies** as in the modern north, medieval communities had to both provision themselves and produce for market exchange. Seasonal scheduling issues and limited labor may have produced conflicts between subsistence and market components of Norse economies, producing

very different type and degree of vulnerability to climate change and culture contact. Both low-bulk prestige goods (walrus ivory, furs, falcons) and staple goods (wool, cloth, preserved fish) played a role in the Viking age, while the later Middle Ages and early Modern period saw the rise of commercial fisheries as a major engine of the wallerstinian proto-world system (Perdikaris & McGovern 2007). Recent zooarchaeological research has greatly expanded our understanding of market production patterns in the N Atlantic. The importance of walrus hunting and walrus ivory in Norse Greenland has long been known, with walrus maxillary fragments from tusk processing appearing on most farms (including inland ones: Gad 1970, Roesdahl 2005,McGovern 1985, 1992, McGovern et al 1996, McGovern & Palsdottir 2006). In 2000 the find of three expertly extracted walrus tusks in a house under the corner of modern Aðalstræti in Reykjavik dated by tephra and radiocarbon to the 870's (over a hundred years before the settlement of Greenland), and the identification of walrus bones (including non-swimming pups) in the nearby midden under Tjarnargata indicate that hunting local Icelandic walrus may have provided an initial objective for the earliest settlers. (McGovern et al. 2001, Sverrisdottir 2006). Several workers have suggested a pre-agricultural hunting settlement may have preceded the well documented elite farmers of the *Book of the Settlements* (Vésteinsson in Sverrisdottir 2006), and Dugmore et al. (2007) suggest that walrus hunters moving from Iceland to the larger and less easily displaced walrus herds of Greenland may have been a key to the Greenlandic settlement. The northern hunt (Norðursetur) in Greenland took scarce labor and valuable boats 800 km north of the settlement areas to walrus-rich Disko Bay in the critical summer season and seems to have involved much of the community in tusk extraction and finishing – baffling previous economic analyses which saw the walrus hunt as supplementing a basically agricultural society (McGovern 1985a). If the walrus hunt was always the main economic focus, these analyses may have gotten things precisely backwards. We need more well dated, stratigraphically excavated archaeofauna from Greenland to better understand what may have been a changing balance between walrus hunting and domestic provisioning during the 500 years of the settlement. At present, we have too few systematically sieved and stratigraphically separated archaeofauna to do more than speculate about these interactions.

The origins of the North Atlantic fisheries that have so dominated the history and settlement of the region since AD 1100 has been a major research question for several teams. A major breakthrough in the zooarchaeology of the undocumented fisheries before 1100 has been achieved in the past five years. A comprehensive review of all extant UK archaeofauna by Barrett et al. (2004a, b) has demonstrated a convincing "fish event horizon (FEH)" of ca AD 950-1050. Before the FEH there are virtually no marine fish bones recovered from British sites more than 10 km from the coast, but after the turn of the 11th c marine fish bones become increasingly common inland and the dense "fish bone middens" appear in the Northern Isles. Thanks to Mývatn archaeofauna from far inland N Iceland (>50 km from the coast) dated by tephra and radiocarbon to AD 871-950 we are now aware of an earlier intra-Nordic production and trade in dried cod-family fish probably dating back to Iron Age N Norway (Perdikaris 1999). The earliest inland settlers of the Mývatn region (well before the FEH in Western Europe) were able to provision themselves with substantial amounts of headless processed cod, haddock, and saithe despite their location (McGovern et al 2007). As figure 1 illustrates, relative percentages of cliethrum (which travels with the partially filleted body) and premaxilla (discarded at the processing site) provide a strong contrast between inland consumers (Hofstaðir 3-4, Sveigakot 2-3, Granastadir, Hrísheimar 1-2), and later coastal sites like the fishing farm at Gjögur (1-2) and the seasonal fishing station at Akurvík (24-22). Note that both Viking age and early medieval phases at Junarkinsfløttur (1-3) in Faroe show a very strong (premaxilla rich) producer signature. The horizontal bar indicates the relative percentages

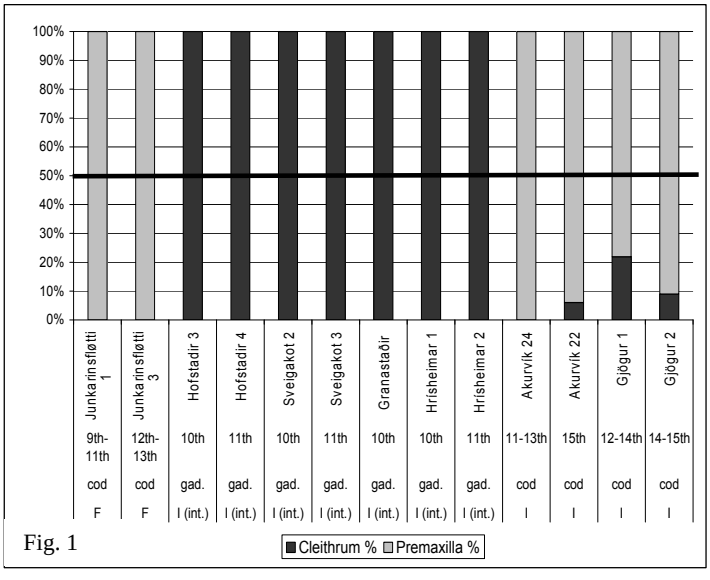
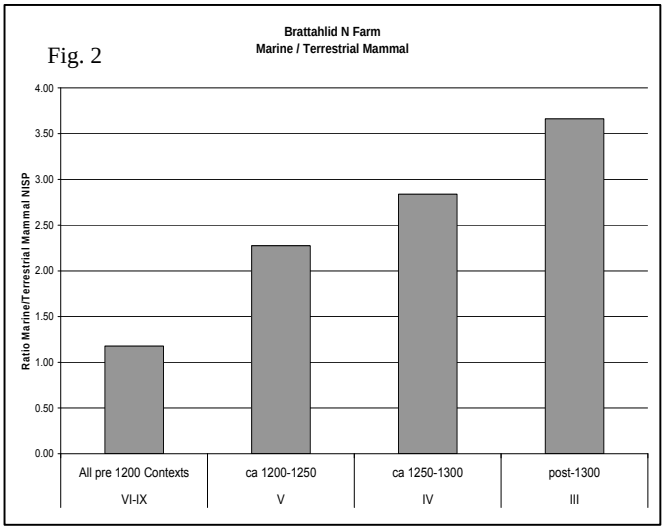


Fig. 1

of these paired elements in a whole fish. Coastal fish production sites dating to the early Viking Age in NW Iceland were often chieftains' farms like Vatnsfjord, drawing wealth from this early intra-Icelandic fish trade rather than from agriculture (Edvardsson 2005, Edvardsson &McGovern 2005). By 1200 there were many specialist fishing farms and seasonal fishing camps in the NW producing for local and possibly overseas consumers (data sets in Amundsen et al 2005, Krivogorskaya et al 2005, for fuller discussion see McGovern, Perdikaris et al 2006, Perdikaris & McGovern 2007). As illustrated in figure 1, excavations on Sandoy in the Faroe Islands 2003-05 (see below) have also documented a pre-FEH cod element distribution in Viking age Faroes very similar to element distribution signatures of later post-FEH specialized fishing stations in Iceland and the Northern Isles of Scotland (Brewington 2007). The ultimate origin of the North Atlantic fisheries thus seems to be Norse (not Celtic or Anglo-Saxon), and originating in the early Viking age prior to the FEH. The beginnings of commercial cod fisheries and fish marketing in the N Atlantic (spreading globally in the 16th-19th c) thus appears to be a previously unrecognized but lasting Scandinavian contribution to world history. While the outlines of the pre-commercial, pre-FEH Norse fish trade are emerging (high species diversity, unstandardized fish cutting, both flat dried and round dried products) and analytic tools have been tested (element distribution, improved species level identification, live length and age at death reconstruction) we are only beginning to model its scope and intensity, and its ultimate connection to the fully commercial world of the later Middle Ages (Perdikaris et al. 2007).

A major unresolved comparative problem is the virtual absence of fish bones from Norse sites in Greenland, especially in light of the early Viking age fish trade in Iceland and the Faroes. All zooarchaeologists and excavators since the 1920's have noted the shortage of fish bones in Greenlandic Norse sites, despite often excellent conditions of organic preservation and (since the 1970's) systematic sieving and flotation. Despite intensive sieving and flotation, the recent 2005-06 excavations in SW Greenland produced one single marine fish bone (McGovern & Palsdottir 2007), while the same crews using the same methods later in the summer collected thousands of fish bones from precisely contemporary sites in Iceland and the Faroes. Isotopic evidence from human bone strongly indicates a significant (and increasing) marine dietary component (Arneborg et al 1999, 2007), a finding supported by the changing ratios of marine/terrestrial bones recovered in 2005-6 from the Brattahlið N farm midden (fig 2), but virtually all these marine fragments are from seals. Since the Greenlanders, Icelanders, and Faroese were all close relatives in the middle ages, speaking mutually comprehensive dialects, ruled by the same monarch, and all practicing the same Latin Christianity, explanations that depend on some ritual prohibition seem unlikely (Diamond 2005). We suspect that a labor/boats/seasonality/scheduling conflict may be the ultimate reason for the Greenlanders substitution of seals for fish in subsistence (Perdikaris & McGovern 2007), but again we need more well dated contexts and larger seal bone collections which can generate more identifiable seal teeth for sectioning and seasonality reconstruction to test the scheduling conflict hypothesis.

Fig. 2



3) Climate impacts: while paleoclimate data management and climate impact modeling are the responsibilities of other parts of the MARENA/NORCLIM team, our zooarchaeological data sets provide key variables (stocking level, mean body weight) for *BuModel* and related Landuse/climate response modeling (Thompson & Simpson 2005,2006 a, b). As Woollett et al (2000) have demonstrated for Labrador/Newfoundland, changing proportions of seal species in archaeofauna can be used as a proxy for ice conditions. In Greenland, changing proportions of seal bones in the stratified Norse middens seem to be providing a proxy indicator for major threshold-crossing climate change in the late 13th-early 14th c. In the eastern arctic, North Atlantic seals such as the harbor or common seal (*Phoca vitulina*) overlap in range with both high-arctic seals (ringed *P hispida*, bearded *E. barbatus*) and migratory ice riding seals (harp *P. groenlandicus*, hooded *C. cristata*). Harbor seal adults can withstand drift ice, but not fast ice, and their

pups are vulnerable to summer drift ice. In modern times, large amounts of drift ice have been carried from E Greenland into the former E Settlement area in summer, and harbor seals are extremely rare in the region today. Summer drift ice does not reach the W Settlement area, and harbor seals are frequently taken there (Hunting Statistics Greenland 1954-76, Vibe 1967). Climatologists have demonstrated that summer drift ice was probably rare or absent in the Viking age; Eirik the Red probably never saw it (Ogilvie & McGovern 2000). Sea cores from Danmark Strait (Jennings & Wiener 1996), the southeast Greenland shelf (Jensen, Kuijpers & Troelstra 2004), and the Igaliku fjord in the center of the E Settlement (Roncaglia & Kuijpers 2004) all suggest a major influx of polar water sometime in the late 13th-early 14th c AD. Roncaglia & Kuijpers (2004) report enhanced wind-induced mixing of the water column in the interval AD 960 – 1285 compared to the period after ca AD 1300. Diatom analyses of core PO 243-443 (Jensen et al. 2004) yield evidence of marked hydrographic changes having occurred in a relatively short time span beginning at about AD 1300 and culminating around AD 1500. This period marks the transition from the Medieval Warm Period to the Little Ice Age, and is characterized by increased inflow of polar E Greenland waters into the inner part of Igaliku Fjord. Moreover, on the Southeast Greenland shelf Jensen (2003) found marked fluctuations of East Greenland Current activity at multi-decadal to centennial scale, becoming more pronounced after c. AD 1200. These oceanographic findings appear to support the model of a threshold crossing "flip over" from warmer conditions without summer drift ice in the E Settlement area to cooling and decrease in summer storminess in the fjords associated with an onset of summer drift ice in the late 13th to early 14th c. Zooarchaeology can provide additional proxy evidence for both climate change and impact on human economy. Figure 3 presents the pattern of seal species abundance from the currently available C14- dated sites and phases in the Eastern and Western Settlements. The decline in common /harbor seals post ca.1250 is evident in both the E17a collection (Narsaq) and the E29N collection (Qassiarsuk). The stratigraphic excavation and the new set of AMS C14 dates for the E29N collection allows fairly precise placement of the seal shift to ca 1250-1300, which correlates with the available core data. In the W Settlement sites there is no similar decline in common seal bones, suggesting that over-hunting is probably not a viable explanation for the changes in the E Settlement pattern, and that climate change and summer drift ice are more likely to be responsible (joint publication with NORCLIM in prep). The onset of summer drift ice in the E Settlement area would have triggered multiple shifts in both marine and terrestrial ecosystems (summer sea ice in Iceland depressed grass growth and contributed to domestic stock mortality, Ogilvie 1984 et seq.) and certainly had major consequences for the economy of the Norse Greenlanders. While this pattern is highly suggestive, we need more well dated stratified archaeofauna from the E Settlement which span the early 13th to 14th c, and a coordinated effort by archaeologists, modelers and climatologists to better understand the timing and consequences of this threshold-crossing climate event.

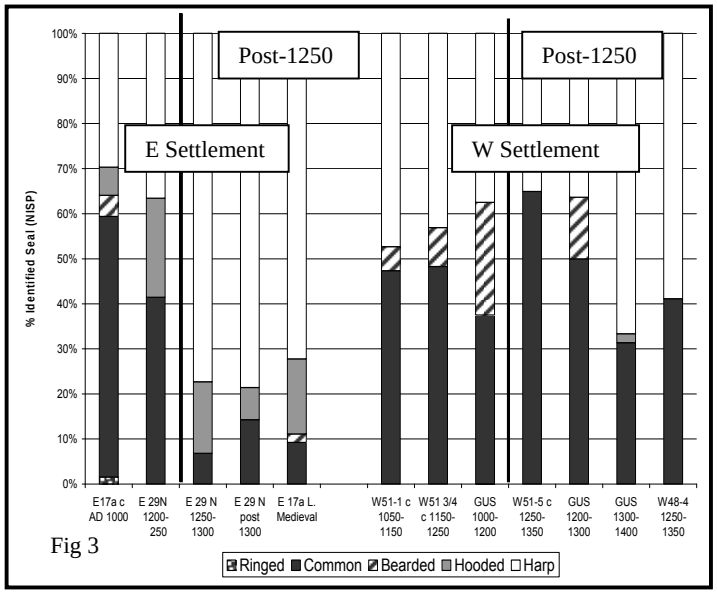


Fig 3

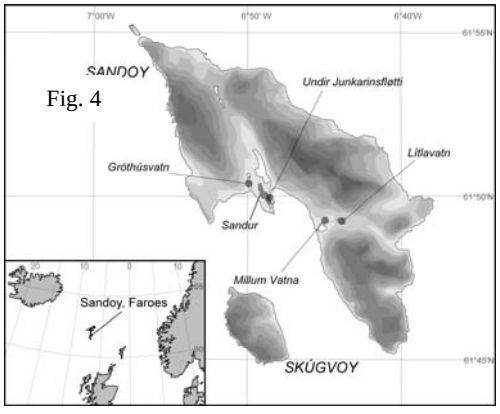


Fig. 4

Proposed Field Projects Supported: **1) Faroes Heart of the Atlantic Project** The Heart of the Atlantic project (HoA) is directed by Simun Arge of the Faroese National Museum, and takes the island of Sandoy as its

regional research focus (figure 4). This project has its roots in long term Faroes Museum investigations centered on Sandur village on Sandoy dating back to the early 20th c, but HoA was launched as an interdisciplinary, international collaboration in 2003 as part of a Leverhulme Trust (UK) funded project *Landscapes Circum Landnám* project (2003-06) involving an investigation of the impacts of first settlement on Faroese landscapes. Since 2005, the HoA project has been a NABO cooperation involving the Faroes Museum, CUNY, U Bradford, U Iceland, and U Durham, with direct connections between Shetland Islands Council, Faroes Tourism Department aiding outreach and community development efforts. A major summary article of the archaeology has appeared in *Environmental Archaeology* (Church et al 2006), and an entire issue of *Human Ecology* (spring 2005) was dedicated to the environmental science evidence. Major funding support for the HoA project has come from the Anadarko Oil Company, and this proposal thus only requests travel support for US participants. The CUNY contribution has been to support major excavations at the deep (>3 m) stratified midden deposits weathering out of sandy cliff faces at Junarkinsfløttur in Sandur village and of midden deposits associated with a Viking age long house at Sondum across the bay. The stratified archaeofauna from these sites are the first published zooarchaeology from the Faroes, and their full analysis will provide a doctoral thesis project for Seth Brewington of the CUNY doctoral program. Exceptional conditions of preservation have produced a massive Junarkinsfløttur archaeofauna (NISP > 200,000) dating from ca AD 850-1250. Most of the deposit remains to be investigated as teams work both from the erosion face and downwards from the bluff top. A timber-floored building dating to the 13th c has been fully exposed, along with what are probably associated yard walls, and major collections have been made from basal Viking-age midden deposits along the erosion face. An enigmatic cultural deposit below what has been considered the first Norse occupation has appeared in this area, and further work is required to determine if this relates to still earlier pre-Norse occupation. As figure 5 illustrates, birds (mainly puffins) and fish (mainly Atlantic cod) dominate the collections from first settlement into the medieval period. No other N Atlantic site has such consistently high percentages of bird bones, which actually increase in relative abundance through time. In Iceland, south coast sites show initially high concentrations of bird bones at first settlement, but this seems to represent a one time draw-down of the natural capital represented by previously un-hunted bird colonies (including some now-extinct great auks), as later Icelandic sites in the same area show much lower bird bone frequencies and much higher proportions of domestic stock (McGovern et al 2001). Faroese fowlers were evidently following a different strategy allowing a long term sustainable yield of large numbers of sea birds, which continued to provide a substantial dietary contribution through the later Middle Ages. As noted above, analysis of fish element distribution patterns from the stratified deposits have revealed that on site processing for export (a strong surplus of head parts vs. tail vertebrae, fig 2) began with first settlement- not in the 11th-12th c as in Orkney and Caithness (Brewington 2007, Perdikaris et al 2007, Barrett et al 2004). As in Iceland, the earliest Scandinavian settlers at Junarkinsfløttur were heavily committed to market production from fishing, and (unlike Iceland) appear to have continued a subsistence economy provisioned as much from fowling as farming. Instead of further intensifying fishing ,the Faroese seem to have expanded fowling, again a strong contrast with Iceland and the Scottish isles. Faroese archaeofauna thus far have provided multiple surprises, and seem to signal an economic trajectory significantly different from medieval Iceland and Greenland, despite a common ancestry.

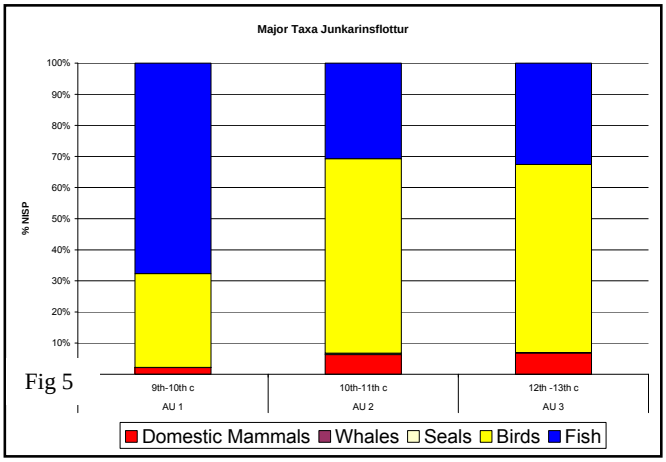
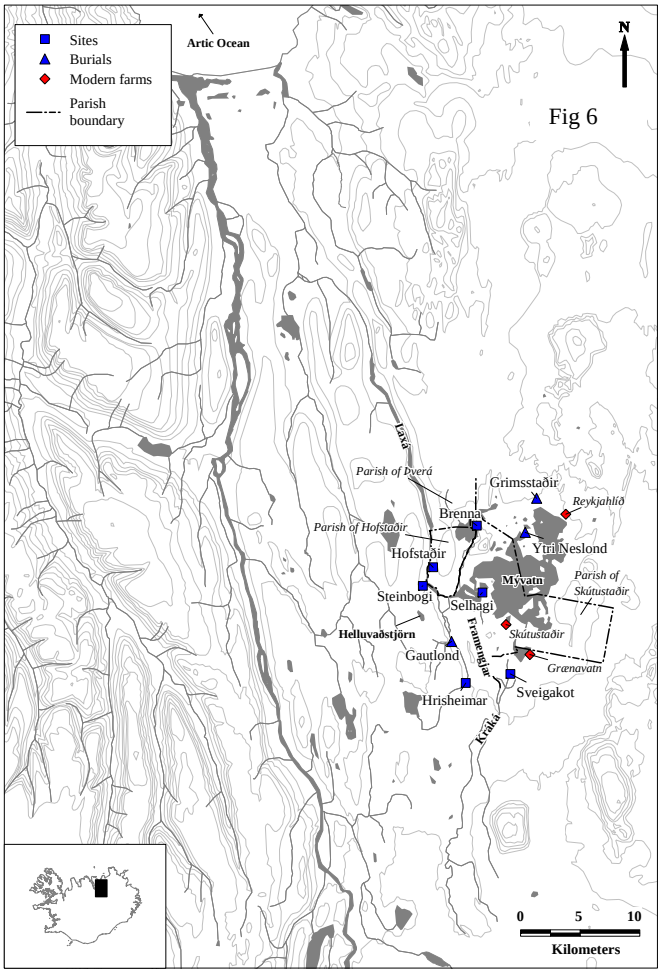


Fig 5

Proposed HoA research plan 2007-9: The Heart of the Atlantic project is progressively expanding from its initial focus upon the eroding cliff face deposits at Junarkinsfløttur, and taking on the entire island of Sandoy as a research region. The island-wide high resolution digital mapping, initial GIS work, and environmental survey work has begun, the mapping of the three excavation areas is complete, multiple pollen cores are extracted, and multiple visible ruins have been located and mapped, and several geophysical prospecting techniques (resistivity, magnetometer, ground penetrating radar) have been tested.

The groundwork for a systematic island-wide program of site survey and selective excavation is thus being established. The next three seasons will see the zooarchaeology team participate in an expansion of excavations to take in other settlement areas on Sandoy (especially shell-sand areas with potentially excellent organic preservation), the investigation of specialized herding structures, and extensive excavations in the Sandur village area. Excavations at the still productive erosion cliff will continue, but additional localities within the modern village will be investigated to get a better understanding of the relationship of the Viking-early medieval settlement and the later village. We plan to recover an archaeofauna from Sandur that will span the entire period from first settlement down to the 19th c., but this will require work at multiple contexts to piece together. Excavations will resume around the modern churchyard (whose chapel is the latest of a series of six buildings extending back to early medieval period) to allow the modern community to expand their burial area. The area outside the modern churchyard is archaeologically rich, and probably contains buildings from an early hall and more burials associated with a pre-Christian cemetery investigated in 2000 (Arge 1988 et seq.). By 2010, we expect to have a far better understanding of the changing landscape of Sandoy since settlement, and to have achieved a far more complete integration of the large Junarkinsfløttur archaeofauna with the broader archaeology of the island.

Proposed Field Projects 2) **Landscape Change in Mývatnssveit N Iceland:** Archaeological research work in the Lake Mývatn region (Mývatnssveit) dates back a century to the pioneering work of Daniel Bruun and Finnur Jónnson at the site of Hofstaðir (Bruun & Jonsson 1908). Mývatn is a World Environmental Heritage site, and an active Mývatn Science Center (directed by Arni Einarsson U Iceland) provides a long term bio-science monitoring station and has been an invaluable source of information, resources, and collaboration. In 1992, Adolf Friðriksson and Orri Vésteinsson re-opened investigations at Hofstaðir, and by 1996 these had expanded into the multi-disciplinary international Landscapes of Settlement project (LoS) and took in the entire lake basin as study area (McGovern, Vesteinsson et al 2007). Multiple volcanic tephra horizons (Dugmore et al 1994 et seq) and 79 AMS radiocarbon dates have established solid chronologies that allow linkage of layers within sites, sites with each other, and with environmental sampling cores and geo-trench profiles. The project has produced large (>10k NISP) stratified archaeofauna from the sites of Hofstaðir, Sveigakot, and Hrísheimar, and smaller but useful archaeofauna from Steinbogi and Selhagi (Fig. 6). Systematic site survey has located over 9,000 features in the Mývatn lake basin area (including graves, wall lines, charcoal pits, iron smelters, seasonal shielings, and farm buildings), pollen cores have been taken from lakes & bogs, and over 60 soil profiles correlated by tephra have established local and regional rates of erosion through time (Simpson, Dugmore et al 2001, Simpson et al 2002,2003,2004, Lawson et al 2005, McGovern et al 2006, 2007). Pre-Christian graves in the area have provided AMS radiocarbon dates on the human, horse, and dog bones regularly recovered, and C and N isotopic studies have indicated that only the horses were completely within the terrestrial food web,

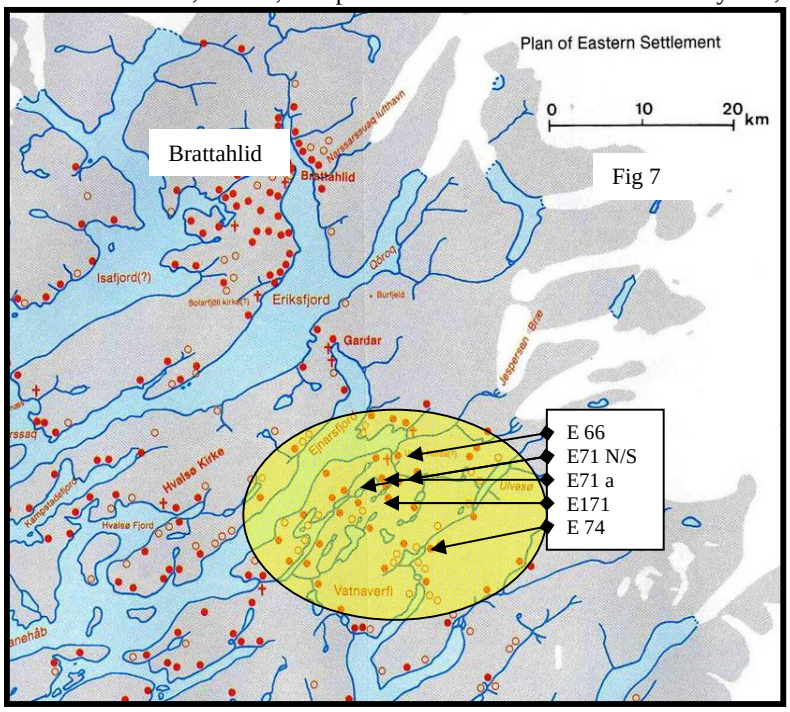


complimenting the zooarchaeological finds of marine fish bones in these inland sites discussed above (McGovern et al 2007). In addition to the early Viking age fish trade, the multiple contemporary archaeofauna from Mývatn have documented millennium scale time depth for ethnographically observed local conservation of lake waterfowl populations. Mývatn residents today take no more than one or two eggs per nest, and normally do not kill adult birds, while sustainably harvesting over 10,000 eggs per year. Archaeofauna dating back to the 9th c proved to be full of egg shell fragments (identified via SEM analysis as mainly duck), while the few bird bones recovered were from local ptarmigan rather than the migratory waterfowl- a remarkable case of local level sustainable resource management on the millennial scale (McGovern et al 2006). Analysis of the Mývatn domestic mammal bones has produced evidence of a major shift in economic strategy ca 1200 AD. Archaeofauna in the Viking age composed of varying amounts of cattle, pig, horse, sheep, and goat bones shift in the early 13th c to a pattern dominated by sheep (with pigs and goats becoming very rare and cattle proportions dropping from around 1 to 4 sheep to 1 to 20 sheep- a pattern still visible in early 18th c registers). Herding pattern reconstruction indicates that many of these sheep were old ewes and castrate wethers, indicating a new emphasis on wool production. At the same time, dental pathologies associated with soil ingestion increase among mature/old sheep jaws in the archaeofauna. Climate impact (Casely 2005) and Rangeland management (Thompson 2005) models indicate that a shift to a wool oriented economy would place heavier pressures on upland grazing just as climate fluctuation would have complicated traditional communal management practice. The result may have been a gradual unraveling of vegetation and soils, which may have not through careless mis-management but from cascading interactions unforeseeable by the 13th c. farmers, whose economic decisions would not produce a disastrous heritage until the 18th century. The Mývatnssveit area thus currently represents one of the most intensively researched portions of the Norse N Atlantic, and provides a unique combination of archaeology, paleoecology and modern ecology which has allowed detailed economic reconstruction and modeling landuse and climate based on multiple data sets- especially zooarchaeology. The experience gained (often by trial and error) from this long term collaborative research effort is being directly applied to the collaborative projects in Faroes and Greenland in an effort to connect mature and early-to-mid phase projects. However, there is also urgent need for more work in the Mývatn area. Most of our current large archaeofauna date to ca AD 875-1000, with some limited 13th c and 18th-19th c material. We lack any archaeofauna from the critical period now identified as the period when the stock-soils-climate dynamic begins to go badly wrong (Vesteinsson 2003). Our sample is also biased towards abandoned sites, and we need long continuous sequences from still occupied sites. **Proposed Mývatn research plan 2007-09:** the zooarchaeology team will focus on deep midden deposits at the still occupied site of Graenavatn (high status site near Sveigakot) in an effort to develop a long sequence from this key site. Graenavatn is the only survivor of three historically known Mývatn chieftain's farms (one is under a gasoline station, the other under an 18th c lava flow) and the farm family is strongly supportive of work on the site. Test investigations at sites on the lakeshore (Ytri Neslond), & in the mid – uplands (Gautlond) will be combined with investigations in the Kráká drainage desert area, where some partially deflated middens have been reported by survey teams. By 2010, we plan to have several continuous archaeological sequences from farms in different environmental zones carrying the detailed economic/ecological story of the Viking age forward in time through the critical late medieval-early modern period to connect with the detailed farm by farm stock and census register of the Jarðabók survey of 1712 (McGovern et al 2006, Vasey 1991, 1996). With the Graenavatn investigations as a core, we plan to add archaeofauna from different ecological zones to better understand the long term human ecodynamics which preserved the lake waterfowl, successfully conserved many lakeside pastures and seems to have gotten management of the uplands just barely (but catastrophically) wrong.

Proposed Field Projects 3) **Resource Use, Mobility, and Cultural Identity- the Norse settlement in Vatnahverfi, S Greenland AD 985-1450.**

This project builds on collaboration with both the SILA center and the Greenland Museum and Archives (NKA) in 2005-06 the excavation of midden deposits at Brattahlið North Farm (modern Qassiarsuk) and a rescue excavation at the inland farm E74 in the Vatnahverfi region (circled on Fig 7), and will collaborate closely with a Danish IPY project coordinated for the MARENA program by SILA funded by the Commission for Scientific Research in Greenland (KVUG) (Arneborg 2007). The Eastern Settlement area was at least three times the size of the Western Settlement, but until recently has received far less modern archaeological attention. The Vatnahverfi study area is an inland district with a range of well preserved Norse farm ruins including both large and small farms- in many ways a close analog to the Icelandic Mývatn region. It is also being developed for agriculture, and jeep trails now connect modern sheep farms

usually making use of Norse pastures. Early E. settlement excavations date to the 1920's (Nørlund 1924; 1930) and the Vatnahverfi was initially surveyed and some sites were excavated 1948-51 by teams led by C.L. Vebaek (1992). Well preserved animal bone was recovered from several sites, and three archaeofauna (E71N, E71S, E167) were large enough to fully quantify (McGovern in Vebaek 1992, Mainland and Halstead 2005). These inland archaeofauna showed surprisingly large amounts of seal bones (40-50% of total NISP, McGovern 1985b) as well as sea birds, walrus, and polar bear elements. As at inland Mývatn, there was a clear connection between inland farms and coastal resources- but with seal and walrus in place of marine fish. Vebaek's work provides an invaluable first view of sites and settlement pattern in the Vatnahverfi, but much more can now be done with modern interdisciplinary approaches. The Vatnahverfi region thus forms a study area comparable in size to Mývatnssveit and Sandoy and like Mývatnssveit the inland location paradoxically allows for a clearer investigation of the distribution of marine resources and their role in subsistence and market production.



In 2005-06 teams from SILA carried out high precision GPS mapping of 450 structures associated with 81 farm ruin groups, providing an excellent basis for landscape and settlement analysis and for selective excavation. In the early summer of 2006, an international NABO/NKA team directed by Claus Andreasen and field supervised by Ragnar Edvardsson (CUNY) carried out a productive rescue excavation of the Vatnahverfi site E74, which was being flooded by a nearby hydro power dam. The site proved to be a small-medium sized farm, and while the archaeofauna is still under analysis it too clearly contains substantial amounts of seal bone. Surprisingly, this inland farm was settled early, with a 11th c long house in the lower layers, and probably abandoned some time before the mid-15th c end of the settlement as a whole. At present, we do not yet know if this pattern of settlement and abandonment (reminiscent of the Mývatn case) is typical of the Vatnahverfi as a whole, but it underscores the need for well dated stratigraphic excavations aimed at both recovering substantial artifactual, zooarchaeological, archaeobotanical, and geoarchaeological samples and at establishing basic settlement chronology. Multiple stratigraphic investigations are needed to unravel the settlement history (how rapidly was the landscape filled? Was there an "overoptimistic pioneer fringe" followed by consolidation as in Iceland? How did social structure influence human strategies and decisions taken? Were there cycles of abandonment & reoccupation? Was the final abandonment sudden or gradual?), to better understand the changing economic organization of the farms (shifting balance of local farming, sealing in the fjords, and Norðursetur hunting), and to assess the impacts of climate change (growing season fluctuations, onset of summer drift ice) and culture contact (arrival of Inuit hunters after 1200). Available archaeofauna at present indicate that Greenlandic farmers continued the Viking age pattern of maintaining nearly equal proportions of sheep and goats, and the documentation of numerous highland milking pens and what are probably summer shielings (Arneborg 2002, Mainland & Halstead 2005, McGovern 1992) further point to poorly understood differences between herd management strategies in Norse Greenland, Iceland, and Faroes with major implications for both subsistence and human impact on landscape. We also have only a limited understanding of the social and economic dynamics of the growing interaction between Norse farmers and Thule hunters in SW Greenland, and the role these may have played in the ultimate replacement of farmers by hunters after 1450. Urgency is added to the proposed research by both modern climate change and the

needs of local agriculture. Arctic warming is definitely affecting archaeological sites in SW Greenland, and deposits which once remained largely frozen all summer are now completely melted (frozen ground was present at Qassiarsuk in 1932 and 1981, but not in 2005-06). Once superb conditions of organic preservation are now degrading, and at least a sample of the once rich middens urgently needs excavation. Modern farmers in SW Greenland are more or less compelled to occupy Norse farm areas due to topography and vegetation, and the NKA and farmer's associations are negotiating to allow the selective and controlled removal of some archaeological features which severely impede mechanization of the modern farms. Proposed fieldwork will address both of these issues by salvaging middens and providing staff and resources to the NKA for mitigation and documentation work integrated into the overall Vatnahverfi investigations.

Proposed Research Vatnahverfi Plan 2007-09: the zooarchaeology team will work closely with our hosts from SILA, NKA and the local museums at Narsaq and Qaqortoq to integrate the midden investigations into the overall KVUG IPY plan, which envisages a systematic shift from survey towards excavation in the next three seasons. Vebaek's notes indicate substantial midden deposits at the farms E71 N, E71S, E 71a, and E171. The deposits at E71 N and S were partially sampled by Vebaek, but were not sieved or excavated stratigraphically. Substantial deposits are known to remain at E71S, and the sites E71a and E171 remain unexcavated. The sites are near neighbors, and probably part of the same administrative unit centered on the church farm E66 (fig 7). If major stratified collections can be made from all three sites they can plausibly be related to economic change on the community level. By 2010, we plan to have three to four large stratified archaeofauna from modern excavations of Vatnahverfi sites well integrated into a program of selective structural excavation and continued systematic site survey, geoarchaeology, and landscape analysis. The research plan will be closely integrated with museum development and exhibition plans at the three local south Greenlandic museums at Narsaq, Qaqortoq, and Nantoralik.

Summary- IPY & Island Connections

This proposal requests US IPY support to provide zooarchaeological support to the MARENA and NORCLIM IPY projects, and to work with our international colleagues in Scandinavia, Holland, Canada, and the UK as part of the Human & Biotic Systems in the Polar Regions (**Humans in Polar Regions**) emphasis area in carrying out international cross disciplinary system science. While this proposal has necessarily focused upon the US IPY MARENA contribution in zooarchaeology, the published record of the NABO research team may serve to demonstrate how the insights of zooarchaeology can be integrated with archaeobotany, geoarchaeology, historical climatology, and environmental modeling (Church et al. 2005; Dugmore et al 2007, Buckland et al 1996 Simpson et al. 2001, 2002, 2003, 2004 McGovern et al 2007). We are attempting to make use of the **pulse of IPY opportunity** to do something **collaborative, innovative, and new** in this key portion of the circumpolar north. We are proposing an ambitious, **potentially transformative** program of multi-scalar three-island integrated research which will directly address key elements of the NSF IPY solicitation under ***Humans in Polar Regions*** (p. 7) "*adaptations of humans and polar communities to life in the polar environment…and how these adaptations developed over time….; the factors contributing to vulnerability, resilience, and sustainability of human cultures in the arctic…..historical or extant forces driving social and economic organization in polar regions; the impact of migrations and culture contact …responses of resource utilization, world economy, and global politics to impacts of polar climate change; the nature and extent of social transformations induced by large scale resource utilization…influence of these transformations on the relationship between demographic, economic, and social trends, and ultimately how they impact the environment"*. This program of international research is closely integrated with the expressed needs of the **northern communities** with whom we have worked – outreach, K-12 education, aid with cultural/environmental tourism, and with inter-community coordination. In **education**, we are committed to fully integrating younger scholars in formal field schools, multi-level peer-mentoring field teams, school-based curriculum development, and informal education (digital teaching tools, presentations, hands-on sessions, media cooperation at national and international levels) and will integrate new and existing educational initiatives with this proposal. Our project also seeks to achieve a **lasting IPY legacy** by establishing lasting links in science, education, and outreach between island communities in the Faroes, Iceland, and Greenland as well as strengthening and expanding links between participating scientists and institutions. **Data management and curation** is a key concern, and this project draws upon a long term NABO effort to create and maintain directly comparable data sets on the regional scale. US IPY support for this project will connect arctic islands, northern residents, interdisciplinary collaborators & students in a new, ambitious, and transformative program of research and education squarely within the IPY tradition.

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